


DC POWER SUPPLY
DPR SERIES, MODEL 6257A
SERIAL NUMBER PREFIX 5L

OPERATING AND SERVICE MANUAL

HEWLETT
PACKARD  HARRISON
DIVISION



CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

DC POWER SUPPLY

DPR SERIES, MODEL 6257A

SERIAL NUMBER PREFIX 5L

Printed: September, 1966

Ⓢ Stock Number: 06257-90001

TABLE OF CONTENTS

Section	Page No.	Section	Page No.
I GENERAL INFORMATION		IV PRINCIPLES OF OPERATION	
1-1. Description	1-1	4-1. Overall Block Diagram	4-1
1-6. Specifications	1-1	Discussion	4-2
1-8. Options	1-1	4-4. Simplified Schematic	4-2
1-10. Instrument Identification	1-2	4-6. Series Regulator	4-2
1-13. Ordering Additional Manuals	1-2	4-8. Constant Voltage Input Circuit	4-3
		4-12. Constant Current Input Circuit	4-4
II INSTALLATION		4-17. Voltage Clamp Circuit	4-5
2-1. Initial Inspection	2-1	4-20. Mixer and Error Amplifiers	4-5
2-3. Mechanical Check	2-1	4-23. Reference Circuit	4-6
2-5. Electrical Check	2-1	4-26. Meter Circuit	4-6
2-7. Installation Data	2-1	4-32. Operation of Regulating	4-7
2-9. Location	2-1	Feedback Loop	4-7
2-11. Rack Mounting	2-1		
2-13. Input Power Requirements	2-1	V MAINTENANCE	
2-15. Connections for 230 Volt		5-1. Introduction	5-1
Operation	2-1	5-3. General Measurement	5-1
2-17. Power Cable	2-2	Techniques	5-1
2-20. Repackaging for Shipment	2-2	5-8. Test Equipment Required	5-3
		5-10. Performance Test	5-4
III OPERATING INSTRUCTIONS		5-12. Constant Voltage Tests	5-6
3-1. Operating Controls and		5-21. Constant Current Tests	5-7
Indicators	3-1	5-25. Troubleshooting	5-7
3-3. Operating Modes	3-1	5-27. Trouble Analysis	5-9
3-5. Normal Operating Mode	3-1	5-35. Repair and Replacement	5-12
3-7. Constant Voltage	3-1	5-37. Adjustment and Calibration	5-12
3-9. Constant Current	3-1	5-39. Meter Zero	5-12
3-11. Connecting Load	3-2	5-41. Voltmeter Tracking	5-12
3-14. Operation of Supply Beyond		5-43. Ammeter Tracking	5-13
Rated Output	3-2	5-45. Constant Voltage Programming	5-13
3-16. Optional Operating Modes	3-2	Current	5-13
3-17. Remote Programming, Constant		5-48. Constant Current Programming	5-13
Voltage	3-2	Current	5-13
3-24. Remote Programming, Constant		5-51. Reference Circuit Adjustments	5-14
Current	3-3	5-55. Constant Voltage Transient	5-14
3-30. Remote Sensing	3-3	Response	5-14
3-35. Series Operation	3-4		
3-39. Parallel Operation	3-5	VI REPLACEABLE PARTS	
3-42. Auto-Tracking Operation	3-5	6-1. Introduction	6-1
3-45. Special Operating Considerations	3-6	6-4. Ordering Information	6-1
3-46. Pulse Loading	3-6	Reference Designators	
3-48. Output Capacitance	3-6	Abbreviations	
3-51. Reverse Voltage Loading	3-6	Manufacturers	
3-53. Reverse Current Loading	3-7	6-8. Code List of Manufacturers	6-2
		Parts List Table	

PRECAUTIONARY NOTICE
DC POWER SUPPLY

This notice applies to Models 6251A, 6253A, 6255A, and 6257A

CAUTION

It has been determined that certain special modes of operation may cause specific components within the power supplies listed above to exceed their ratings. Although there is no record of failure as a result of these special modes of operation, we are issuing this notice as a precautionary measure.

The only modes of operation which may under certain combinations of operating conditions place a strain on specific components within the power supply are:

1. Parallel Operation. However, use of Auto-Parallel operation is not restricted and will not result in any unusual component strain. Moreover, Auto-Parallel operation insures equal current sharing and is preferable to ordinary parallel operation in any case.
2. Battery Charge or Discharge -- under the condition that the battery voltage is greater than the front panel voltage control setting of the power supply.
3. Use of the power supply as a sink rather than a source, without the addition of a suitable preload resistor.

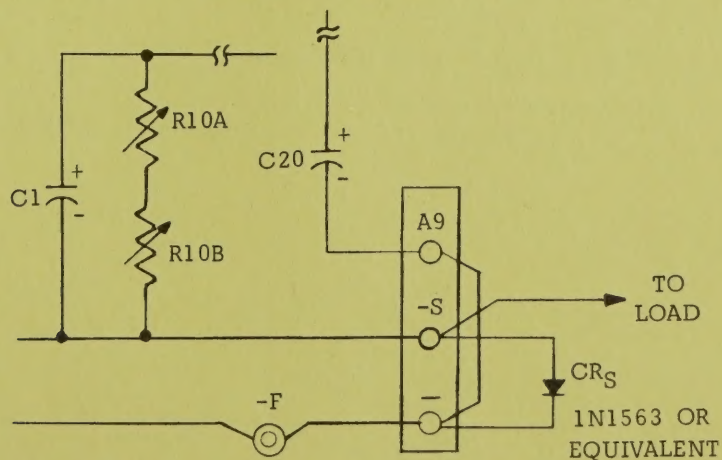
The above modes of operation result in an extra strain being placed on the "suck-down" transistor Q4, which has been included in the circuitry for the purpose of enhancing down-programming speed (of the order of 1 ms).

If the power supply is to be used in any of the above modes of operation, a diode may be added in series with the negative output terminal to prevent current from flowing backwards into the power supply and through transistor Q4. Negative sensing can be connected around this diode to retain normal regulation properties. A simple method of making this connection directly on the rear barrier strip is to remove strapping between terminals A9 and -S, and then connect diode CR_S as shown on the sketch below.

It is not recommended that this diode be added unless the supply will be used in one of the three modes of operation above, which would normally result in an external source forcing current backwards through the power supply terminals and through Q4. The addition of this diode has the disadvantage of degrading transient recovery and output impedance at high frequencies.

Future production units will include a modification which will permit normal operation of the supply for all modes without an external diode.

Do not hesitate to contact the factory if there are any questions concerning ways in which these models can be adapted to the special modes of operation listed above.



Diode Modification

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

Table	Page No.	Table	Page No.
1-1 Specifications	1-3	5-5 Common Troubles	5-9
5-1 Test Equipment Required	5-2	5-6 Selected Semiconductor Characteristics	5-9
5-2 Reference Circuit Troubleshooting	5-7	5-7 Checks and Adjustments After Replacement of Semiconductor Devices	5-10
5-3 High Output Voltage Troubleshooting	5-8	5-8 Calibration Adjustment Summary	5-12
5-4 Low Output Voltage Troubleshooting	5-8		

LIST OF ILLUSTRATIONS

Figure	Page No.	Figure	Page No.
1-1 DC Power Supply	iv	4-4 Constant Current Input Circuit, Simplified Schematic	4-4
2-1 Primary Connections	2-1	4-5 Voltage Clamp Circuit, Simplified Schematic	4-5
3-1 Front Panel Controls and Indicators	3-1	4-6 Mixer and Error Amplifiers, Simplified Schematic	4-5
3-2 Normal Strapping Pattern	3-1	4-7 Meter Circuit, Simplified Schematic	4-6
3-3 Remote Resistance Programming (Constant Voltage)	3-2	4-8 Voltmeter Connections, Simplified Schematic	4-7
3-4 Remote Voltage Programming (Constant Voltage)	3-3	4-9 Ammeter Connections, Simplified Schematic	4-7
3-5 Remote Resistance Programming (Constant Current)	3-3	5-1 Front Panel Terminal Connections	5-1
3-6 Remote Voltage Programming (Constant Current)	3-3	5-2 Output Current Measurement Technique	5-1
3-7 Remote Sensing	3-4	5-3 Differential Voltmeter Substitute, Test Setup	5-3
3-8 Normal Series Connections	3-4	5-4 Output Current, Test Setup	5-4
3-9 Auto-Series, Two and Three Units	3-5	5-5 Load Regulation, Constant Voltage	5-4
3-10 Normal Parallel Connections	3-5	5-6 Ripple and Noise, Constant Voltage	5-5
3-11 Auto-Parallel, Two Units	3-5	5-7 Transient Response, Test Setup	5-5
3-12 Auto-Tracking, Two and Three Units	3-6	5-8 Transient Response, Waveforms	5-5
4-1 Overall Block Diagram	4-1	5-9 Output Impedance, Test Setup	5-6
4-2 Simplified Schematic	4-2	5-10 Servicing Printed Wiring Boards	5-11
4-3 Constant Voltage Input Circuit, Simplified Schematic	4-3		

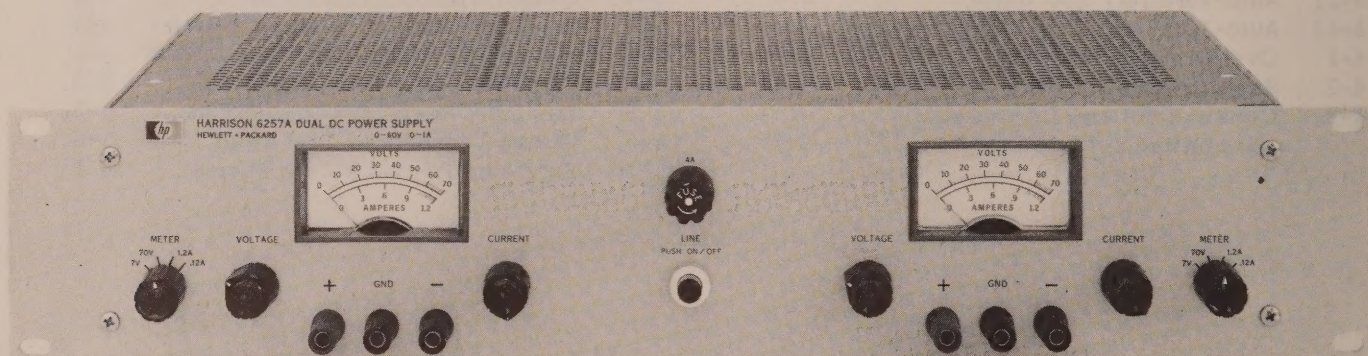


Figure 1-1. DC Power Supply, Model 6257A

SECTION I GENERAL INFORMATION

1-1 DESCRIPTION

1-2 This power supply, Figure 1-1, is completely transistorized and suitable for either rack or bench operation. It is a dual supply consisting of two independently controlled sections; both identical to each other. Each section is a well-regulated, Constant Voltage/Constant Current source that will furnish full rated output voltage at the maximum rated output current or can be continuously adjusted throughout either output range. The front panel CURRENT controls can be used to establish the output current limit (overload or short circuit) when the supply is used as a constant voltage source and the VOLTAGE control(s) can be used to establish the voltage limit (ceiling) when the supply is used as a constant current source. Each section will automatically crossover from constant voltage to constant current operation and vice versa if the output current or voltage exceeds these preset limits.

1-3 Each supply has both front and rear terminals. Either the positive or negative output terminal may be grounded or the power supply can be operated floating at up to a maximum of 300 volts off ground.

1-4 Each section has its own front panel meter and operating controls. The meters are of the multiple range type and can measure output voltage or current. The voltage or current ranges are selected by the applicable METER switch on the front panel.

1-5 Two sets of programming terminals located at the rear of the unit allow ease in adapting to the many operational capabilities of the power supply. A brief description of these capabilities is given below:

a. Remote Programming

The power supply may be programmed from a remote location by means of an external voltage source or resistance.

b. Remote Sensing

The degradation in regulation which would occur at the load because of the voltage drop in the load leads can be reduced by using the power

supply in the remote sensing mode of operation.

c. Series and Auto-Series Operation

Power supplies may be used in series when a higher output voltage is required in the voltage mode of operation or when greater voltage compliance is required in the constant current mode of operation. Auto-Series operation permits one knob control of the total output voltage from a "master" supply.

d. Parallel and Auto-Parallel Operation

The power supply may be operated in parallel with a similar unit when greater output current capability is required. Auto-Parallel operation permits one knob control of the total output current from a "master" supply.

e. Auto-Tracking

The power supply may be used as a "master" supply, having control over one (or more) "slave" supplies that furnish various voltages for a system.

1-6 SPECIFICATIONS

1-7 Detailed specifications for the power supply are given in Table 1-1.

NOTE

Since both sections of this supply are identical, only one section will be discussed throughout the remaining portions of this manual. All descriptions, illustrations, tests, and adjustments apply equally to both sections of the supply.

1-8 OPTIONS

1-9 Options are factory modifications of a standard instrument that are requested by the customer. The following options are available for the instrument covered by this manual. Where necessary, detailed coverage of the options is included throughout the manual.


<u>Option No.</u>	<u>Description</u>	<u>Option No.</u>	<u>Description</u>
06	<p>Overvoltage Protection "Crowbar": A completely separate circuit for protecting delicate loads against power supply failure or operator error. This independent device monitors the output voltage and within 10μsec imposes a virtual short-circuit (crowbar) across the power supply output if the preset overvoltage margin is exceeded. When Option 06 is requested by the customer the device is attached to the rear of the power supply at the factory. This option is not available for Model 6251A supplies.</p> <p><u>Overvoltage Margin:</u> 1 to 4 volts, screwdriver adjustable.</p> <p><u>Power Requirement:</u> 15ma continuous drain from power supply being protected.</p> <p><u>Size:</u> Add 5 inches to power supply depth dimension.</p> <p><u>Weight:</u> Add 2 lbs. net.</p> <p>NOTE Detailed coverage of Option 06 is included in an addendum at the rear of manuals that support power supplies containing Option 06.</p>	10	Chassis Slides: Enables convenient access to power supply interior for maintenance purposes.
		13	Three Digit Graduated Decadal Voltage Control: Control that replaces coarse and fine voltage controls permitting accurate resettability.
		14	Three Digit Graduated Decadal Current Control: Control that replaces coarse and fine current controls permitting accurate resettability.
		28	Rewire For 230V AC Input: Supply as normally shipped is wired for 115 Vac input. Option 28 consists of reconnecting the input transformer for 230 Vac operation.
		<u>1-10 INSTRUMENT IDENTIFICATION</u>	
		1-11	Hewlett-Packard power supplies are identified by a three-part serial number tag. The first part is the power supply model number. The second part is the serial number prefix, which consists of a number-letter combination that denotes the date of a significant design change. The number designates the year, and the letter A through L designates the month, January through December respectively. The third part is the power supply serial number.
		1-12	If the serial number prefix on your power supply does not agree with the prefix on the title page of this manual, change sheets are included to update the manual. Where applicable, backdating information is given in an appendix at the rear of the manual.
		<u>1-13 ORDERING ADDITIONAL MANUALS</u>	
		1-14	One manual is shipped with each power supply. Additional manuals may be purchased from your local Hewlett-Packard field office (see list at rear of this manual for addresses). Specify the model number, serial number prefix, and  stock number provided on the title page.
07	Voltage 10-Turn Pot: A single control that replaces both coarse and fine voltage controls and improves output settability. Standard item on Model 6258A power supplies.		
08	Current 10-Turn Pot: A single control that replaces both coarse and fine current controls and improves output settability.		
09	Voltage and Current 10-Turn Pot: Consists of Options 07 and 08 on the same instrument.		

Table 1-1. Specifications

INPUT:

105-125/210-250 VAC, single phase,
50-400 cps.

OUTPUT:

Two independent outputs each of which can
be set at 0-60 volts @ 0-1 amp.

LOAD REGULATION:

Constant Voltage -- Less than 0.01% plus
2 mv for a full load to no load change in output
current.

Constant Current -- Less than 0.01% plus
250 μ a for a zero to maximum change in output
voltage.

LINE REGULATION:

Constant Voltage -- Less than 0.01% plus
2mv for any line voltage change within the input
rating.

Constant Current -- Less than 0.01% plus
250 μ a for any line voltage change within the in-
put rating.

RIPPLE AND NOISE:

Constant Voltage -- Less than 200 μ v rms.
Constant Current -- Less than 500 μ a rms.

TEMPERATURE RANGES:

Operating: 0 to 50°C. Storage: -20 to +85°C.

TEMPERATURE COEFFICIENT:

Constant Voltage -- Less than 0.02% plus
500 μ v per degree Centigrade.

Constant Current -- Less than 0.02% plus
0.5ma per degree Centigrade.

STABILITY:

Constant Voltage -- Less than 0.10% plus
2.5mv total drift for 8 hours after an initial warm-
up time of 30 minutes at constant ambient, con-
stant line voltage, and constant load.

Constant Current -- Less than 0.10% plus
7.5ma total drift for 8 hours after an initial warm-up
time of 30 minutes at constant ambient, constant
line voltage, and constant load.

**INTERNAL IMPEDANCE AS A CONSTANT VOLTAGE
SOURCE:**

Less than 0.001 ohm from DC to 100 cps.
Less than 0.01 ohm from 100 cps to 1Kc.
Less than 0.2 ohm from 1 Kc to 100Kc.
Less than 2.0 ohms from 100 Kc to 1 Mc.

TRANSIENT RECOVERY TIME:

Less than 50 μ sec for output recovery to within
15 mv following a full load current change in the
output.

OVERLOAD PROTECTION:

A continuously acting constant current circuit
protects the power supply for all overloads in-
cluding a direct short placed across the termi-
nals in constant voltage operation. The constant
voltage circuit limits the output voltage in the
constant current mode of operation.

METERS:

Each front panel meter can be used as either a
0-70V or 0-7 volt voltmeter or as a 0-1.2 or 0-0.12
amp ammeter.

OUTPUT CONTROLS:

Coarse and fine voltage controls and coarse
and fine current controls set desired output voltage
or current.

OUTPUT TERMINALS:

Six "five-way" output posts (three per section)
are provided on the front panel and output terminal
strips are located on the rear of the chassis. All
power supply output terminals are isolated from
the chassis and either the positive or negative
terminals may be connected to the chassis
through a separate ground terminal located on the
output terminal strip.

ERROR SENSING:

Error sensing is normally accomplished at the
front terminals if the load is attached to the front
or at the rear terminals if the load is attached to
the rear terminals. Also, provision is included
on the rear terminal strip for remote sensing.

REMOTE PROGRAMMING:

Remote programming of the supply output at ap-
proximately 300 ohms per volt in constant voltage
is made available at the rear terminals. In con-
stant current mode of operation, the current can be
remotely programmed at approximately 1000 ohms
per ampere.

COOLING:

Convection cooling is employed. The supply
has no moving parts.

SIZE:

3-1/2" H x 14-1/2" D x 19" W. Easily rack
mounted in a standard 19" relay rack.

WEIGHT:

28 lbs. net, 35 lbs. shipping.

FINISH:

Light gray front panel with dark gray case.

POWER CORD:

A three-wire, five-foot power cord is provided
with each unit.

SECTION II INSTALLATION

2-1 INITIAL INSPECTION

2-2 Before shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing materials until the inspection is completed. If damage is found, proceed as described in the Claim for Damage in Shipment section of the warranty page at the rear of this manual.

2-3 MECHANICAL CHECK

2-4 This check should confirm that there are no broken knobs or connectors, that the cabinet and panel surfaces are free of dents and scratches, and that the meter is not scratched or cracked.

2-5 ELECTRICAL CHECK

2-6 The instrument should be checked against its electrical specifications. Section V includes an "in-cabinet" performance check to verify proper instrument operation.

2-7 INSTALLATION DATA

2-8 The instrument is shipped ready for bench operation. It is necessary only to connect the instrument to a source of power and it is ready for operation.

2-9 LOCATION

2-10 This instrument is air cooled. Sufficient space should be allotted so that a free flow of cooling air can reach the sides and rear of the instrument when it is in operation. It should be used in an area where the ambient temperature does not exceed 50°C.

2-11 RACK MOUNTING

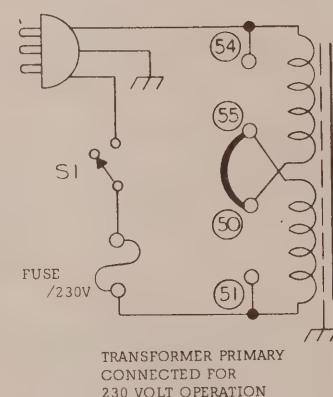
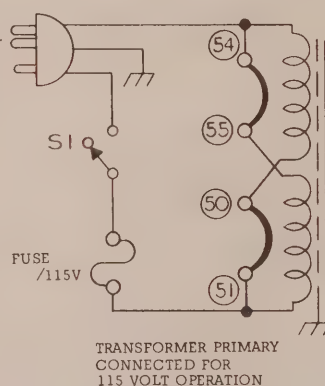
2-12 This instrument is full rack size and can be easily rack mounted in a conventional 19 inch rack panel using standard mounting screws.

2-13 INPUT POWER REQUIREMENTS

2-14 This power supply may be operated from either a nominal 115 volt or 230 volt 50-400 cycle

power source. The unit, as shipped from the factory, is wired for 115 volt operation. The input power required when operated from a 115 volt 60 cycle power source at full load is 235 watts and 2.6 amperes.

2-15 CONNECTIONS FOR 230 VOLT OPERATION (Figure 2-1)



NOTE: CONNECTIONS BETWEEN 50 & 51, 54 & 55, ARE MADE WITH COPPER ON THE PRINTED CIRCUIT BOARD. THESE CONNECTIONS MUST BE REMOVED FOR 230V OPERATION. THE CONNECTIONS ON THE PRINTED CIRCUIT BOARD MUST BE BROKEN AND A SEPARATE EXTERNAL CONNECTION MADE BETWEEN POINTS 50 & 55.

Figure 2-1. Primary Connections

2-16 Normally, the two primary windings of the input transformer are connected in parallel for operation from 115 volt source. To convert the power supply to operation from a 230 volt source, the power transformer windings are connected in series as follows:

a. Unplug the line cord and remove the unit covers.

b. Break the copper between 54 and 55 and also between 50 and 51 on the printed circuit board. These are shown in Figure 2-1, and are labeled on copper side of printed circuit board.

c. Add strap between 50 and 55.

d. Replace existing fuse with 2 ampere, 230 volt fuse. Return unit to case and operate normally.

2-17 POWER CABLE

2-18 To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three conductor power cable. The third conductor is the ground conductor and when the cable is plugged into an appropriate receptacle, the instrument is grounded. The offset pin on the power

cable three-prong connector is the ground connection.

2-19 To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to ground.

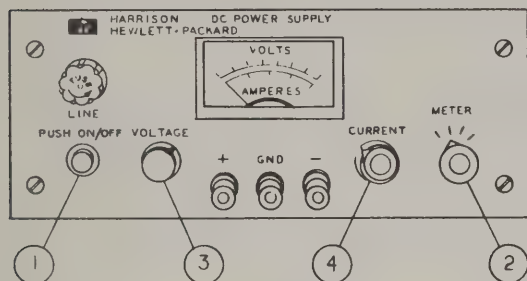
2-20 REPACKAGING FOR SHIPMENT

2-21 To insure safe shipment of the instrument, it is recommended that the package designed for the instrument be used. The original packaging material is reusable. If it is not available, contact your local Hewlett-Packard field office to obtain the materials. This office will also furnish the address of the nearest service office to which the instrument can be shipped. Be sure to attach a tag to the instrument which specifies the owner, model number, full serial number, and service required, or a brief description of the trouble.

SECTION III OPERATING INSTRUCTIONS

3-1 OPERATING CONTROLS AND INDICATORS

3-2 The front panel controls and indicators, together with the normal turn-on sequence, are shown in Figure 3-1.



TURN-ON SEQUENCE

1. PUSH ON/OFF BUTTON AND BUTTON SHOULD LIGHT.
2. SET METER SWITCH TO DESIRED VOLTAGE RANGE.
3. ADJUST COARSE AND FINE VOLTAGE CONTROLS UNTIL DESIRED OUTPUT VOLTAGE IS INDICATED ON METER.
4. SET METER SWITCH DESIRED CURRENT RANGE AND SHORT CIRCUIT OUTPUT TERMINALS.
5. ADJUST CURRENT CONTROLS FOR DESIRED OUTPUT CURRENT.
6. REMOVE SHORT AND CONNECT LOAD TO OUTPUT TERMINALS (FRONT OR REAR).

Figure 3-1. Front Panel Controls and Indicators

3-3 OPERATING MODES

3-4 The power supply is designed so that its mode of operation can be selected by making strapping connections between particular terminals on the terminal strip at the rear of the power supply. The terminal designations are stenciled in white on the power supply above their respective terminals. Although the strapping patterns illustrated in this section show the positive terminal grounded, the operator can ground either terminal or operate the power supply up to 300 vdc off ground (floating). The following paragraphs describe the procedures for utilizing the various operational capabilities of the power supply. A more theoretical description concerning the operational features of this supply is contained in a power supply Application Manual and in various Tech. Letters published by the Harrison Division. Copies of these can be obtained from your local Hewlett-Packard field office.

3-5 NORMAL OPERATING MODE

3-6 The power supply is normally shipped with its rear terminal strapping connections arranged for Constant Voltage/Constant Current, local sensing, local programming, single unit mode of operation. This strapping pattern is illustrated in Figure 3-2. The operator selects either a constant voltage or a constant current output using the front panel controls (local programming, no strapping changes are necessary).

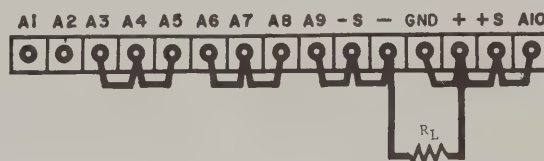


Figure 3-2. Normal Strapping Pattern

3-7 CONSTANT VOLTAGE

3-8 To select a constant voltage output, proceed as follows:

- a. Turn-on power supply and adjust VOLTAGE controls for desired output voltage (output terminals open).
- b. Short output terminals and adjust CURRENT controls for maximum output current allowable (current limit), as determined by load conditions. If a load change causes the current limit to be exceeded, the power supply will automatically cross-over to constant current output at the preset current limit and the output voltage will drop proportionately. In setting the current limit, allowance must be made for high peak current which can cause unwanted cross-over. (Refer to Paragraph 3-46).

3-9 CONSTANT CURRENT

3-10 To select a constant current output, proceed as follows:

- a. Short output terminals and adjust CURRENT controls for desired output current.
- b. Open output terminals and adjust VOLTAGE controls for maximum output voltage allowable (voltage limit), as determined by load conditions. If a load change causes the voltage limit

to be exceeded, the power supply will automatically crossover to constant voltage output at the preset voltage limit and the output current will drop proportionately. In setting the voltage limit, allowance must be made for high peak voltages which can cause unwanted crossover. (Refer to Paragraph 3-46).

3-11 CONNECTING LOAD

3-12 Each load should be connected to the power supply output terminals using separate pairs of connecting wires. This will minimize mutual coupling effects between loads and will retain full advantage of the low output impedance of the power supply. Each pair of connecting wires should be as short as possible and twisted or shielded to reduce noise pickup. (If shield is used, connect one end to power supply ground terminal and leave the other end unconnected.)

3-13 If load considerations require that the output power distribution terminals be remotely located from the power supply, then the power supply output terminals should be connected to the remote distribution terminals via a pair of twisted or shielded wires and each load separately connected to the remote distribution terminals. For this case, remote sensing should be used (Paragraph 3-20).

3-14 OPERATION OF SUPPLY BEYOND RATED OUTPUT

3-15 The shaded area on the front panel meter face indicates the amount of output voltage or current that is available in excess of the normal rated output. Although the supply can be operated in this shaded region without being damaged, it cannot be guaranteed to meet all of its performance specifications. However, if the line voltage is maintained above 115 Vac, the supply will probably operate within its specifications.

3-16 OPTIONAL OPERATING MODES

3-17 REMOTE PROGRAMMING, CONSTANT VOLTAGE

3-18 The constant voltage output of the power supply can be programmed (controlled) from a remote location if required. Either a resistance or voltage source can be used for the programming device. The wires connecting the programming terminals of the supply to the remote programming device should be twisted or shielded to reduce noise pick-up. The VOLTAGE controls on the front panel are disabled according to the following procedures.

3-19 Resistance Programming (Figure 3-3). In this mode, the output voltage will vary at a rate determined by the programming coefficient (200 ohms per volt for Models 6251A, 6253A, and 6255A or 300 ohms per volt for Models 6257A and 6258A). The output voltage will increase 1 volt for each 200 ohms (or 300 ohms) added in series with the programming terminals. The programming coefficient is determined by the programming current. This current is factory adjusted to within 2% of 5 ma for Models 6251A, 6253A, and 6255A or 2% of 3.3 ma for Models 6257A and 6258A. If greater programming accuracy is required, it may be achieved by changing resistor R13.

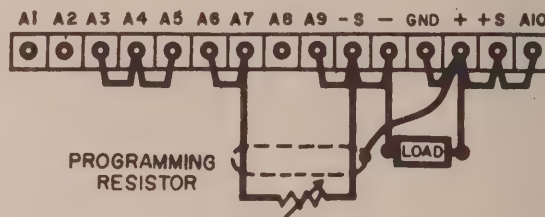


Figure 3-3. Remote Resistance Programming (Constant Voltage)

3-20 The output voltage of the power supply should be zero volts ± 20 millivolts when zero ohms is connected across the programming terminals. If a zero ohm voltage closer than this is required, it may be achieved by changing resistor R6 or R8 as described in Paragraph 5-46.

3-21 To maintain the stability and temperature coefficient of the power supply, use programming resistors that have stable, low noise, and low temperature (less than 30 ppm per degree Centigrade) characteristics. A switch can be used in conjunction with various resistance values in order to obtain discrete output voltages. The switch should have make-before-break contacts to avoid momentarily opening the programming terminals during the switching interval.

3-22 Voltage Programming (Figure 3-4). Employ the strapping pattern shown on Figure 3-4 for voltage programming. In this mode, the output voltage will vary in a 1 to 1 ratio with the programming voltage (reference voltage) and the load on the programming voltage source will not exceed 25 microamperes.

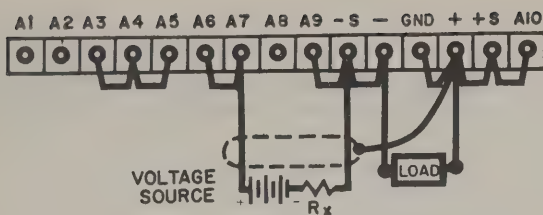


Figure 3-4. Remote Voltage Programming (Constant Voltage)

3-23 The impedance matching resistors (R_x) for the programming voltage source should be approximately 1000 ohms to maintain the temperature and stability specifications of the power supply.

3-24 REMOTE PROGRAMMING, CONSTANT CURRENT

3-25 Either a resistance or a voltage source can be used to control the constant current output of the supply. The CURRENT controls on the front panel are disabled according to the following procedures.

3-26 Resistance Programming (Figure 3-5). In this mode, the output current varies at a rate determined by the programming coefficient --200 ohms per ampere for Model 6251A, 500 ohms per ampere for Models 6253A and 6255A, and 1000 ohms per ampere for Models 6257A and 6258A. The programming coefficient is determined by the Constant Current programming current (5ma for Model 6251A, 2 ma for Models 6253A and 6255A, and 1 ma for Models 6257A and 6258A). This current is adjusted to within 10% at the factory. If greater programming accuracy is required, it may be achieved by changing resistor R19 as outlined in Section V.

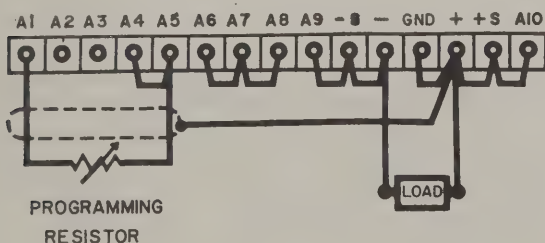


Figure 3-5. Remote Resistance Programming (Constant Current)

3-27 Use stable, low noise, low temperature coefficient (less than 30 ppm/ $^{\circ}$ C) programming resistors to maintain the power supply temperature coefficient and stability specifications. A switch may be used to set discrete values of output current. A make-before-break type of switch should be used since the output current will exceed the maximum rating of the power supply if the switch contacts open during the switching interval.

CAUTION

If the programming terminals (A1 and A5) should open at any time during this mode, the output current will rise to a value that may damage the power supply and/or the load. To avoid this possibility, connect a resistor across the programming terminals having the value listed below. Like the programming resistor, this resistor should be of the low noise, low temperature coefficient

Model	6251A	6253A	6255A	6257A	6258A
Resistance(ohms)	1K	1.5K	750	1K	750

3-28 Voltage Programming (Figure 3-6). In this mode, the output current will vary linearly with changes in the programming voltage. The programming voltage should not exceed 1.5 volts. Voltage in excess of 1.5 volts will result in excessive power dissipation in the instrument and possible damage.

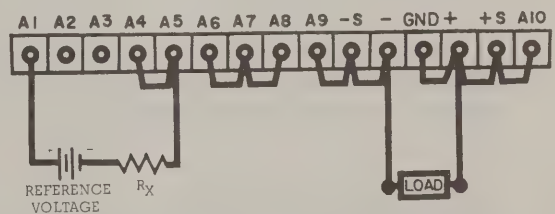


Figure 3-6. Remote Voltage Programming (Constant Current)

3-29 The output current will be the programming voltage divided by 1 ohm. The current required from the voltage source will be less than 25 microamperes. The impedance matching resistor (R_x) should be approximately 500 ohms if the temperature coefficient and stability specifications of the power supply are to be maintained.

3-30 REMOTE SENSING (See Figure 3-7)

3-31 Remote sensing is used to maintain good regulation at the load and reduce the degradation of regulation which would occur due to the voltage drop in the leads between the power supply and the load. Remote sensing is accomplished by utilizing the strapping pattern shown in Figure 3-7. The power supply should be turned off before changing strapping patterns. The leads from the +S terminals to the load will carry less than 10 milliamperes of current, and it is not required that these leads be as heavy as the load leads. However, they must be twisted or shielded to minimize noise pick-up.

CAUTION

Observe polarity when connecting the sensing leads to the load.

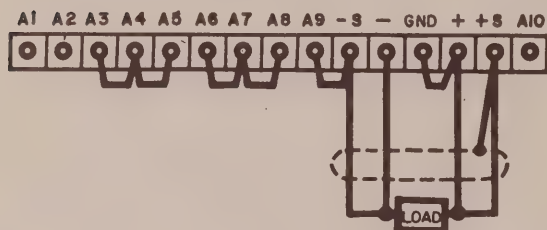


Figure 3-7. Remote Sensing

3-32 Note that it is desirable to minimize the drop in the load leads and it is recommended that the drop not exceed 1 volt per lead if the power supply is to meet its DC specifications. If a larger drop must be tolerated, please consult a Hewlett-Packard field representative.

NOTE

Due to the voltage drop in the load leads, it may be necessary to re-adjust the current limit in the remote sensing mode.

3-33 The procedure just described will result in a low DC output impedance at the load. If a low AC impedance is required, it is recommended that the following precautions be taken:

- Disconnect output capacitor C20 by disconnecting the strap between A9 and -S.
- Connect a capacitor having similar characteristics (approximately same capacitance, same voltage rating or greater, and having good high frequency characteristics) across the load using short leads.

3-34 Although the strapping patterns shown in Figures 3-3 through 3-6 employ local sensing, note that it is possible to operate a power supply simultaneously in the remote sensing and Constant Voltage/Constant Current remote programming modes.

3-35 SERIES OPERATION

3-36 Normal Series Connections (Figure 3-8).

Two or more power supplies can be operated in series to obtain a higher voltage than that available from a single supply. When this connection is

used, the output voltage is the sum of the voltages of the individual supplies. Each of the individual supplies must be adjusted in order to obtain the total output voltage. The power supply contains a protective diode connected internally across the output which protects the supply if one power supply is turned off while its series partner(s) is on.

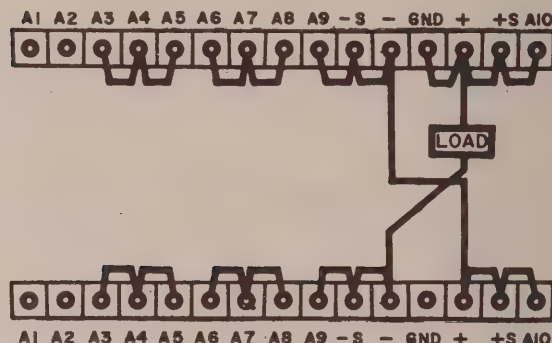


Figure 3-8. Normal Series Connections

3-37 Auto-Series Connections (Figure 3-9). The Auto-Series configuration is used when it is desirable to have the output voltage of each of the series connected supplies vary in accordance with the setting of a control unit. The control unit is called the master; the controlled units are called slaves. At maximum output voltage, the voltage of the slaves is determined by the setting of the front panel VOLTAGE control on the master. The master supply must be the most positive supply of the series. The output CURRENT controls of all series units are operative and the current limit is equal to the lowest control setting. If any output CURRENT controls are set too low, automatic crossover to constant current operation will occur and the output voltage will drop. Remote sensing and programming can be used; however, the strapping arrangements shown in the applicable figures show local sensing and programming.

3-38 In order to maintain the temperature coefficient and stability specifications of the power supply, the external resistors (R_x) shown in Figure 3-9 should be stable, low noise, low temperature coefficient (less than 30 ppm per degree Centigrade) resistors. The value of each resistor is dependant on the maximum voltage rating of the "master" supply. The value of R_x is this voltage divided by the voltage programming current of the slave supply ($1/K_p$ where K_p is the voltage programming coefficient). The voltage contribution of the slave is determined by its voltage control setting.

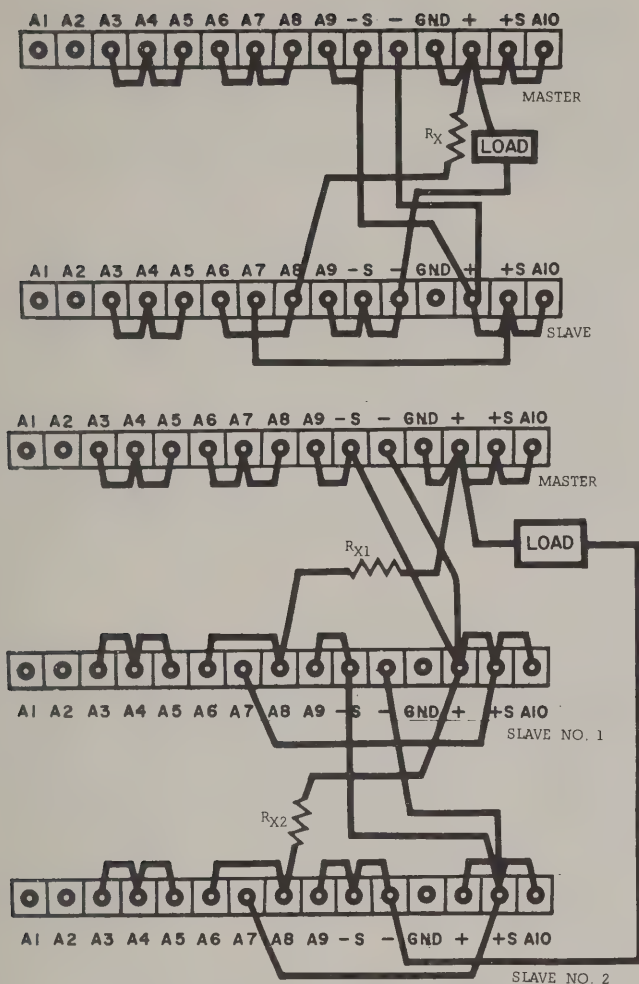


Figure 3-9. Auto-Series, Two and Three Units

3-39 PARALLEL OPERATION

3-40 Normal Parallel Connections (Figure 3-10). Two or more power supplies can be connected in parallel to obtain a total output current greater than that available from one power supply. The total output current is the sum of the output currents of the individual power supplies. The output CURRENT controls of each power supply can be separately set. The output voltage controls of one power supply should be set to the desired output voltage; the other power supply should be set for a slightly larger output voltage. The supply set to the lower output voltage will act as a constant voltage source; the supply set to the higher output voltage will act as a constant current source, dropping its output voltage until it equals that of the other supply. The constant voltage source will deliver only that fraction of its total rated output current which is necessary to fulfill the total current demand.

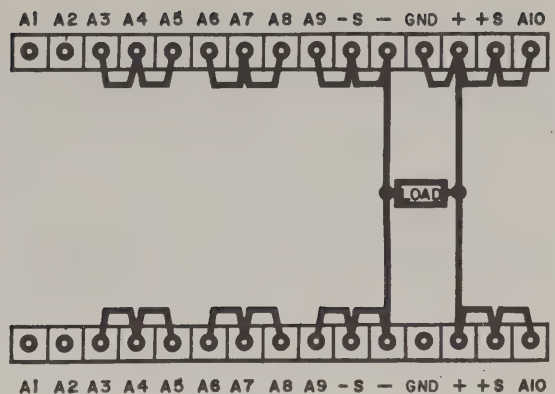


Figure 3-10. Normal Parallel Connections

3-41 Auto-Parallel. The strapping patterns for Auto-Parallel operation of two power supplies are shown in Figure 3-11. Auto-Parallel operation permits equal current sharing under all load conditions, and allows complete control of output current from one master power supply. The output current of each slave will be approximately equal to the master's regardless of the load conditions. Because the output current controls of each slave are operative, they should be set to maximum to avoid having the slave revert to constant current operation; this would occur if the master output current setting exceeded the slave's.

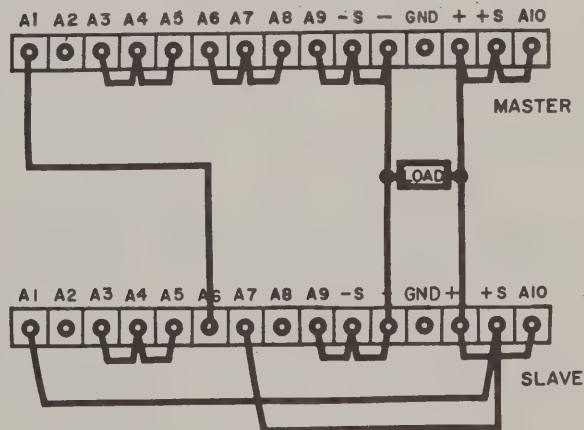


Figure 3-11. Auto-Parallel, Two Units

3-42 AUTO-TRACKING OPERATION (See Figure 3-12)

3-43 The Auto-Tracking configuration is used when it is necessary that several different voltages referred to a common bus, vary in proportion to the setting of a particular instrument (the control or master). A fraction of the master's output voltage

is fed to the comparison amplifier of the slave supply, thus controlling the slave's output. The master must have the largest output voltage of any power supply in the group (must be the most positive supply in the example shown on Figure 3-12).

supply, the external resistors should be stable, low noise, low temperature (less than 30 ppm per °C) resistors.

3-45 SPECIAL OPERATING CONSIDERATIONS

3-46 PULSE LOADING

3-47 The power supply will automatically cross over from constant voltage to constant voltage to constant current operation, or the reverse, in response to an increase (over the preset limit) in the output current or voltage, respectively. Although the preset limit may be set higher than the average output current or voltage, high peak currents or voltages (as occur in pulse loading) may exceed the preset limit and cause crossover to occur. If this crossover limiting is not desired, set the preset limit for the peak requirement and not the average.

3-48 OUTPUT CAPACITANCE

3-49 An internal capacitor, connected across the output terminals of the power supply, helps to supply high-current pulses of short duration during constant voltage operation. Any capacitance added externally will improve the pulse current capability, but will decrease the safety provided by the constant current circuit. A high-current pulse may damage load components before the average output current is large enough to cause the constant current circuit to operate.

3-50 The effects of the output capacitor during constant current operation are as follows:

- The output impedance of the power supply decreases with increasing frequency.
- The recovery time of the output voltage is longer for load resistance changes.
- A large surge current causing a high power dissipation in the load occurs when the load resistance is reduced rapidly.

3-51 REVERSE VOLTAGE LOADING

3-52 A diode is connected across the output terminals. Under normal operating conditions, the diode is reverse biased (anode connected to negative terminal). If a reverse voltage is applied to the output terminals (positive voltage applied to negative terminal), the diode will conduct, shunting current across the output terminals and limiting the voltage to the forward voltage drop of the diode. This diode protects the series transistors and the output electrolytic capacitor.

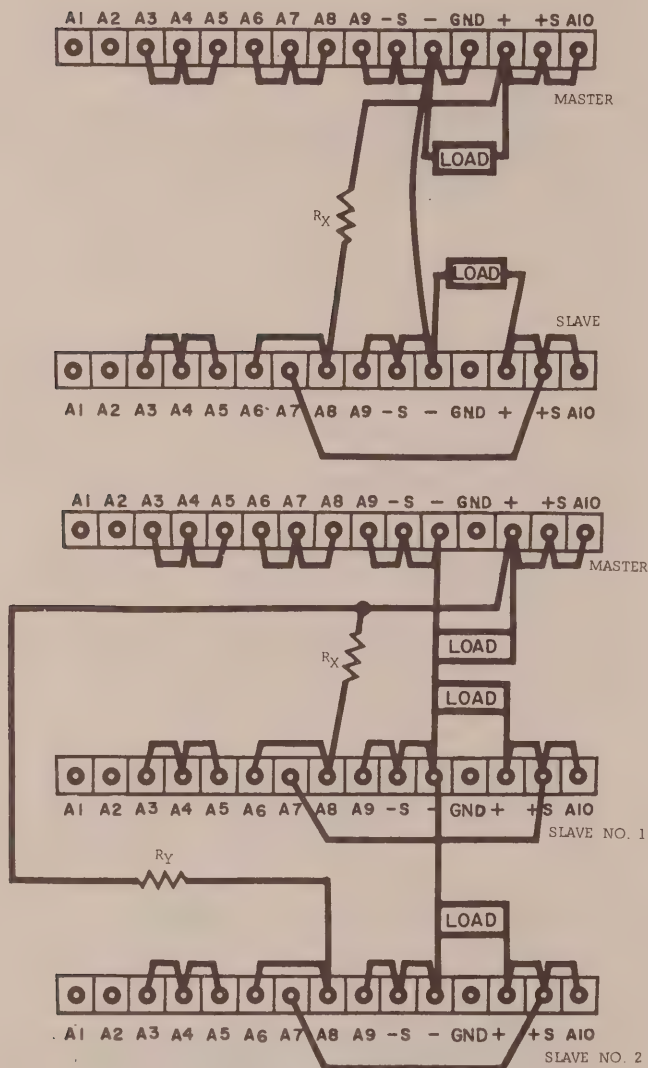


Figure 3-12. Auto-Tracking, Two and Three Units

3-44 The output voltage of the slave is a percentage of the master's output voltage, and is determined by the voltage divider consisting of R_x (or R_y) and the voltage control of the slave supply, R_p , where: $E_s = R_p / R_x + R_p$. Turn-on and turn-off of the power supplies is controlled by the master. Remote sensing and programming can be used; although the strapping patterns for these modes show only local sensing and programming. In order to maintain the temperature coefficient and stability specifications of the power

3-53 REVERSE CURRENT LOADING

3-54 Active loads connected to the power supply may actually deliver a reverse current to the power supply during a portion of its operating cycle. An external source cannot be allowed to pump current

into the supply without loss of regulation and possible damage to the output capacitor. To avoid these effects, it is necessary to preload the supply with a dummy load resistor so that the power supply delivers current through the entire operating cycle of the load device.

SECTION IV PRINCIPLES OF OPERATION

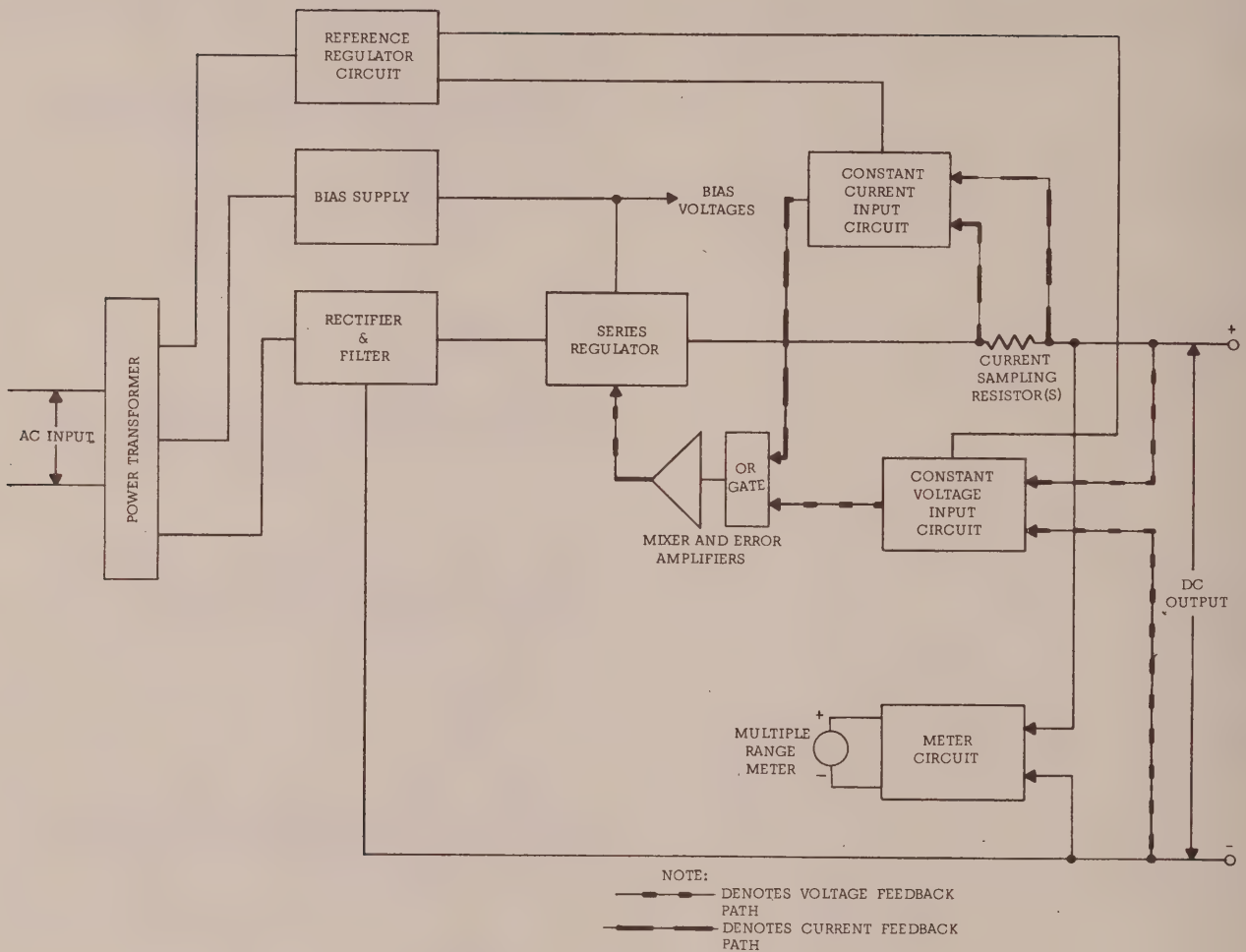


Figure 4-1. Overall Block Diagram

4-1 OVERALL BLOCK DISCUSSION

4-2 The power supply, as shown on the overall block diagram on Figure 4-1, consists of a power transformer, a rectifier and filter, a series regulator, the mixer and error amplifiers, an "OR" gate, a constant voltage input circuit, a constant current input circuit, a reference regulator circuit, a bias supply, and a metering circuit.

4-3 The input line voltage passes through the power transformer to the rectifier and filter where it is converted to raw DC. The DC current passes through the series regulator to the positive output terminal via the current sampling resistor(s). The regulator, part of the feedback loop, is made to alter its conduction to maintain a constant output

voltage or current. The voltage developed across the current sampling resistor(s) is the input to the constant current input circuit. The output voltage of the power supply is sampled by the voltage input circuit by means of the sensing terminals ($\pm S$). Any changes in output voltage/current are detected in the constant voltage/constant current input circuit, amplified by the mixer and error amplifiers, and applied to the series regulator in the correct phase and amplitude to counteract any change in output voltage/output current. The reference circuit provides stable reference voltages which are used by the constant voltage/current input circuits for comparison purposes. The bias supply furnishes voltages which are used throughout the instrument for biasing purposes. The meter circuit provides an indication of output voltage or current.

or less, in accordance with summing point voltage change. The resultant output error voltage is fed back to the series regulator via the remaining components of the feedback loop. Resistor R1, in series with the base Q1A, limits the current through the programming resistors during rapid voltage turn-down. Diodes CR1 and CR2 form a limiting network which prevent excessive voltage excursions from over driving stage Q1A. Capacitors C1 and C2, shunting the programming resistors, increase the high frequency gain of the input amplifier. Resistor R13, shunting pullout resistor R12, serves as a trimming adjustment for the programming current.

4-12 CONSTANT CURRENT INPUT CIRCUIT (Figure 4-4)

4-13 This circuit is similar in appearance and operation to the constant voltage input circuit. It consists of the coarse and fine current programming resistors (R16A and R16B), and a differential amplifier stage (Q2 and associated components). Like transistor Q1 in the voltage input circuit, Q2 consists of two transistors, having matched characteristics, that are housed in a single package.

4-14 The constant current input circuit continuously compares a fixed reference voltage with the voltage drop across current sampling resistor(s). If a difference exists, the differential amplifier produces an

error voltage which is proportional to this difference. The remaining components in the feedback loop (amplifiers and series regulator) function to maintain the drop across the current sampling resistor, and consequently the output current, at a constant value.

4-15 Stage Q2B is connected to the +S through impedance equalizing resistor R26. Resistors R25 and R28 are used to zero bias the input stage, offsetting minor base to emitter voltage differences in Q2. Instantaneous changes in output current on the positive line are felt at the current summing point and, hence, the base of Q2A. Stage Q2A varies its conduction in accordance with the polarity of the change at the summing point. The change in Q2A's conduction also varies the conduction of Q2B due to the coupling effects of the common emitter resistor, R22. The error voltage is taken from the collector Q2B and fed back to the series regulator through OR-gate diode CR4 and the remaining components of the feedback loop. The error voltage then varies the conduction of the regulator so that the output current is maintained at the proper level.

4-16 Resistor R20, in conjunction with R21 and C3, helps stabilize the feedback loop. Diode CR5 limits voltage excursions on the base of Q2A. Resistor R19, shunting the pullout resistor, serves as a trimming adjustment for the programming current flowing through R16A and B.

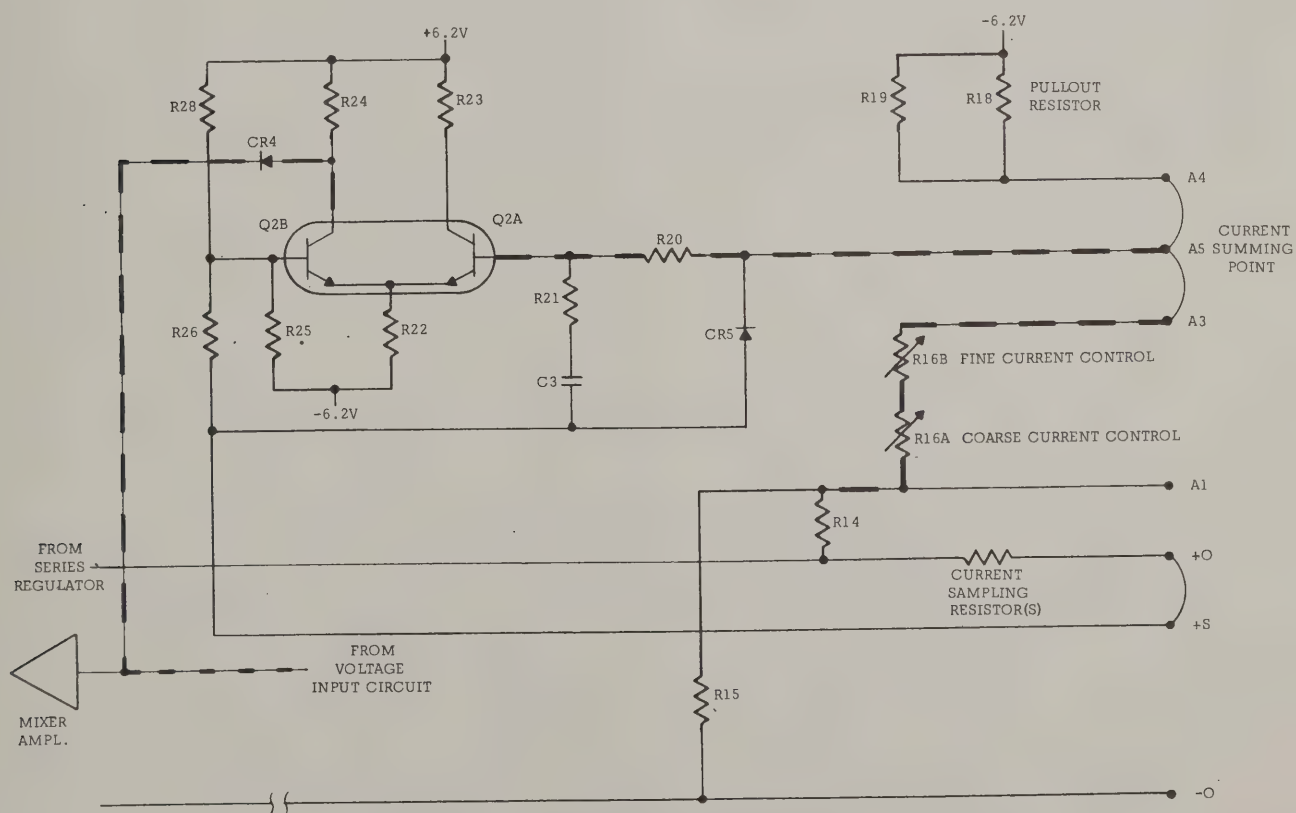


Figure 4-4. Constant Current Input Circuit, Simplified Schematic

4-17 VOLTAGE CLAMP CIRCUIT (Figure 4-5)

4-18 The voltage clamp circuit keeps the constant voltage programming current relatively constant when the power supply is operating in the constant current mode. This is accomplished by clamping terminal A6, the voltage summing point, to a fixed bias voltage. During constant current operation the constant voltage programming resistors are a shunt load across the output terminals of the power supply. When the output voltage changes, the current through these resistors also tends to change. Since this programming current flows through the current sampling resistor(s) it is erroneously interpreted as a load change by the current input circuit. The clamp circuit eliminates this undesirable effect by maintaining the constant voltage programming current constant.

4-19 The voltage divider, R51, R52, and CR31, back biases CR30 and Q10 during constant voltage operation. When the power supply goes into constant current operation, CR30 becomes forward biased by the collector voltage of Q1A. This results in conduction of Q10 and the clamping of the summing point at a potential only slightly more negative than the normal constant voltage potential. Clamping this voltage at approximately the same potential that exists in constant voltage operation, results in a constant voltage across, and consequently a constant current through, the current pullout resistor (R12).

4-20 MIXER AND ERROR AMPLIFIERS (Figure 4-6)

4-21 The mixer and error amplifiers amplify the error signal from the constant voltage or constant current input circuit to a level sufficient to drive the series regulator transistors. The emitter bias po-

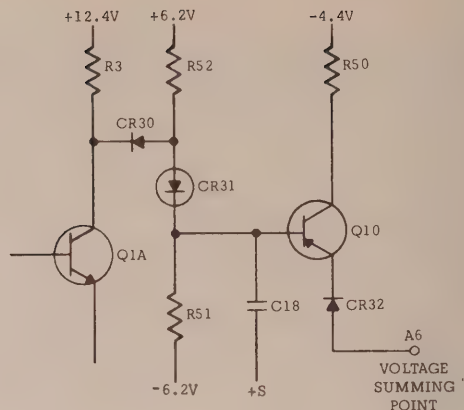


Figure 4-5. Voltage Clamp Circuit

tential for mixer amplifier Q3 is established by voltage divider CR6, CR7, R29. Transistor Q3 receives the error voltage input from either the constant voltage or constant current circuit via the OR-gate diode (CR3 or CR4) that is conducting at the time. Diode CR3 is forward biased, and CR4 reversed biased, during constant voltage operation. The reverse is true during constant current operation.

4-22 The RC network, composed of C5 and R30, is an equalizing network which provides for high frequency roll off in the loop gain response in order to stabilize the feedback loop. Emitter follower transistors Q4 and Q5 are the error amplifiers serving as the driver and predriver elements, respectively, for the series regulator. Transistor Q4, together with diode CR17, provides a low resistance discharge path for the output capacitance of the power supply during rapid down programming.

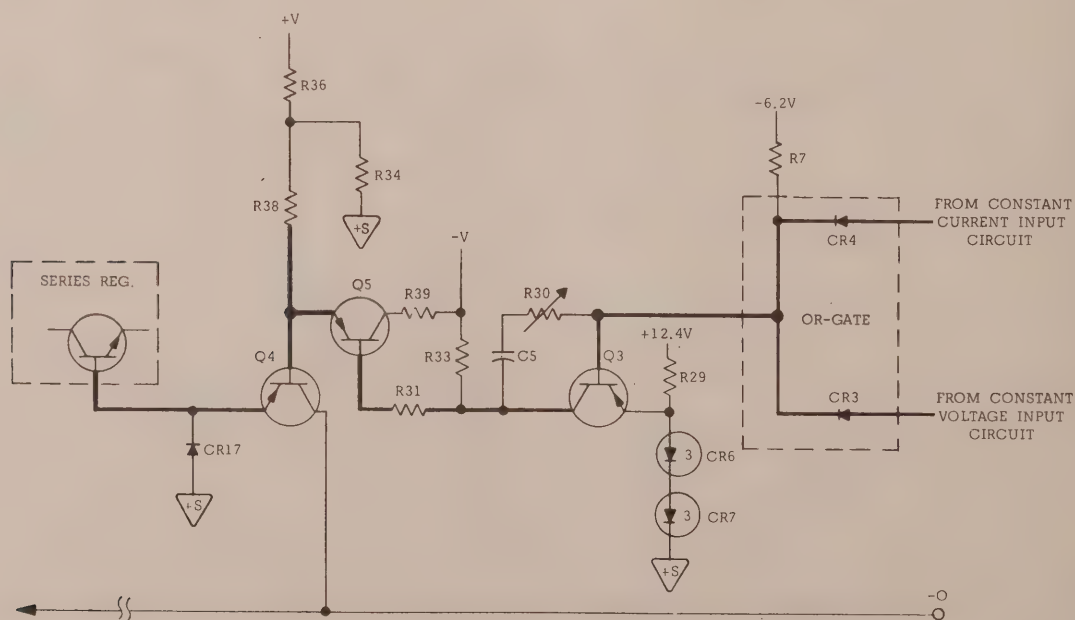


Figure 4-6. Mixer and Error Amplifiers, Simplified Schematic

4-23 REFERENCE CIRCUIT

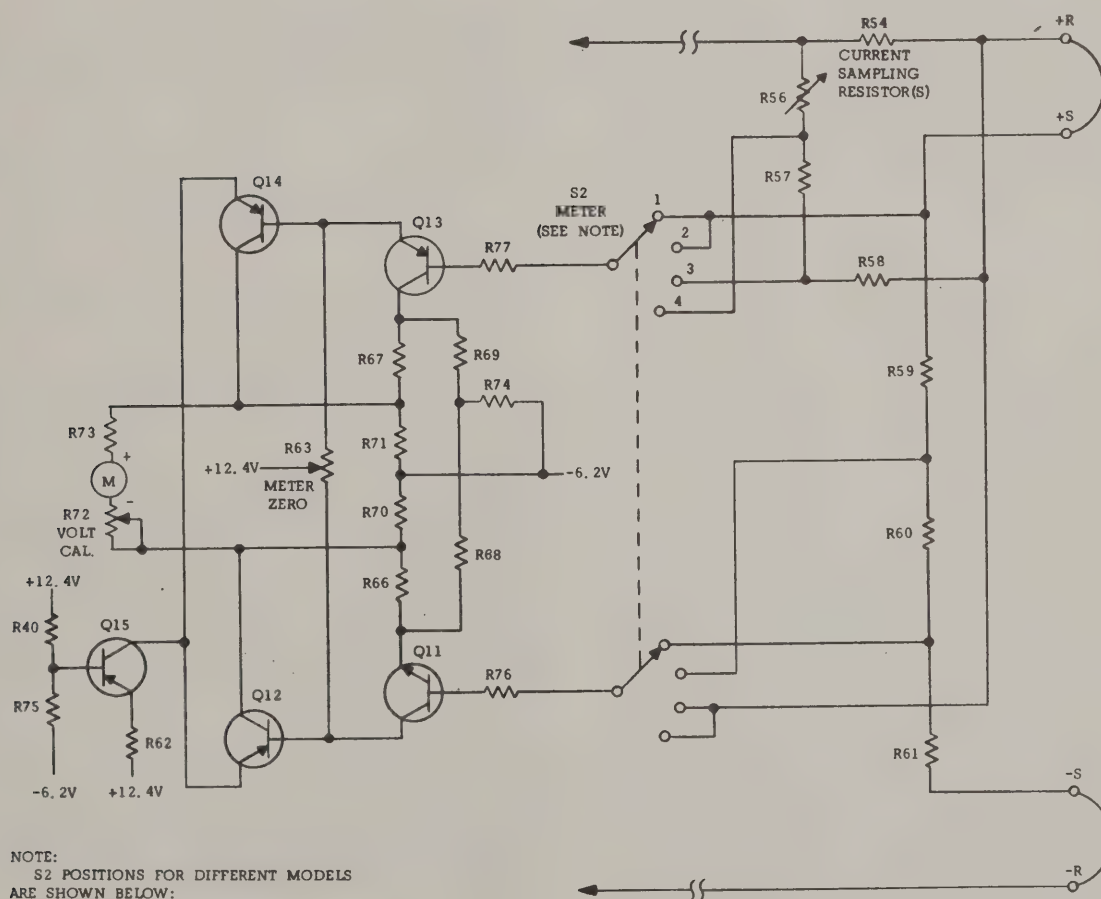
4-24 The reference circuit (see schematic) is a feedback power supply similar to the main supply. It provides stable reference voltages which are used throughout the unit. The reference voltages are all derived from smoothed dc obtained from the full wave rectifier (CR22 and CR23) and filter capacitor C10. The +6.2 and -6.2 voltages, which are used in the constant voltage and current input circuits for comparison purposes, are developed across temperature compensated Zener diodes VR1 and VR2. Resistor R43 limits the current through the Zener diodes to establish an optimum bias level.

4-25 The regulating circuit consists of series regulating transistor Q9 and error amplifier Q8. Output voltage changes are detected by Q8 whose base is

connected to the junction of a voltage divider (R41, R42) connected directly across the supply. Any error signals are amplified and inverted by Q8 and applied to the base of series transistor Q9. The series element then alters its conduction in the direction and by the amount necessary to maintain the voltage across VR1 and VR2 constant. Resistor R46, the emitter resistor for Q8, is connected in a manner which minimizes changes in the reference voltage caused by variations in the input line. Output capacitor C9 stabilizes the regulator loop.

4-26 METER CIRCUIT (Figure 4-7)

4-27 The meter circuit provides continuous indications of output voltage or current on a single multiple range meter. The meter can be used either as a voltmeter or an ammeter depending upon the position of METER switch S2 on the front panel of the supply.



MODEL	S2 TERMINAL NOS.			
	1	2	3	4
6251A	.9V	9V	6A	.6A
6253A	2.4V	24V	4A	.4A
6255A	5V	50V	1.8A	.18A
6257A	7V	70V	1.2A	.12A
6258A	12V	120V	.9A	.09A

Figure 4-7. Meter Circuit, Simplified Schematic

This switch also selects one of two meter ranges on each scale. The metering circuit consists basically of a selection circuit (switch S2 and associated voltage dividers), a stable differential amplifier stage (Q11 through Q14), and the meter movement.

4-28 The selection circuit determines which voltage divider is connected to the differential amplifier input. When S2 is in one of the voltage positions, the voltage across divider R59, R60, and R61 (connected across the output of the supply) is the input to the differential amplifier. When S2 is in one of the current positions, the voltage across divider R56, R57, and R58 (connected across the sampling resistor network) is the input to the differential amplifier. The amplified output of the differential amplifier is used to deflect the meter.

4-29 The differential amplifier is a stable device having a fixed gain of ten. Stage Q11 of the differential amplifier receives a negative voltage from the applicable voltage divider when S2 is in one of the voltage positions while stage Q13 is connected to the +S (common) terminal. With S2 in a current position, stage Q13 receives a positive voltage from the applicable voltage divider while stage Q11 is connected to the +S terminal. The differential output of the amplifier is taken from the collectors of Q12 and Q14. Transistor Q15 is a constant current source which sets up the proper bias current for the amplifier. Potentiometer R63 permits zeroing of the meter. The meter amplifier stage contains an inherent current limiting feature which protects the meter movement against overloads. For example, if METER switch S2 is placed in position 4, (low current range) when the power supply is actually delivering a higher ampere output, the differential amplifiers are quickly driven into saturation limiting the current through the meter to a safe value.

4-30 Figures 4-8 and 4-9 show the meter connections when S2 is in the higher voltage and current positions, respectively. For the sake of simplicity, some of the actual circuit components are not shown on these drawings. With METER switch S2 in the higher voltage range, position (2), the voltage drop across R59 is the input to the meter amplifier and the meter indicates the output voltage across the +S and -S terminals. For low output voltages, S2 can be switched to position 1 resulting in the application of a larger percentage of the output voltage (drop across R59 and R60) to the meter amplifier.

4-31 With S2 in the higher current range position (Figure 4-9) the voltage drop across R58 is applied to the meter amplifier and the meter indicates the output current which flows through R54. For low values of output current, S2 can be switched to

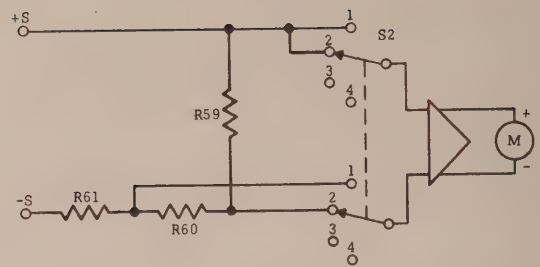


Figure 4-8. Voltmeter Connections, Simplified Schematic

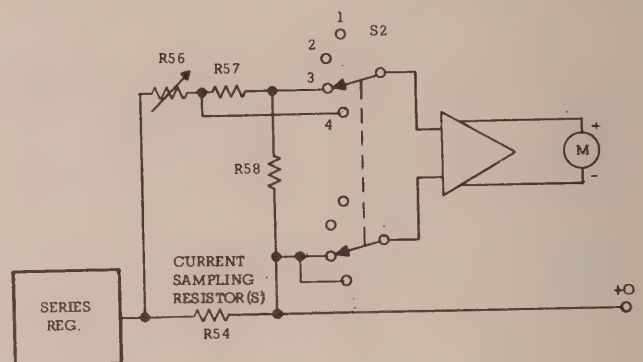


Figure 4-9. Ammeter Connections, Simplified Schematic

position 4 and the voltage drop across R57 and R58 is applied to the meter amplifier.

4-32 OPERATION OF REGULATING FEEDBACK LOOP

4-33 The feedback loop functions continuously to keep the output voltage constant, during constant voltage operation, and the output current constant, during constant current operation. For purposes of this discussion, assume that the unit is in constant voltage operation and that the programming resistors have been adjusted so that the supply is yielding the desired output voltage. Further assume that the output voltage instantaneously rises (goes positive) due to a variation in the external load circuit.

4-34 Note that the change may be in the form of a slow rise in the output voltage or a positive going ac signal. An ac signal is coupled to summing point A6 through capacitor C1 and a dc voltage is coupled to A6 through R10.

4-35 The rise in output voltage causes the voltage at A6 and thus the base of Q1A to decrease (go negative). Q1A now decreases its conduction and its collector voltage rises. The positive going error voltage is amplified and inverted by Q3 and fed to

the base of series transistor Q6 via the emitter follower(s). The negative going input causes Q6 to decrease its conduction so that it drops more of the line voltage, and reduces the output voltage to its original level.

4-36 If the external load resistance is decreased to a certain crossover point, the output current increases until transistor Q2A begins to conduct. During this time, the output voltage has also decreased to a level so that the base of Q1A is at a high positive potential. With Q1A in full conduction,

its collector voltage decreases by the amount necessary to back bias OR gate diode CR3 and the supply is now in the constant current mode of operation. The crossover point at which constant current operation commences is determined by the setting of CURRENT control R16. The operation of the feedback loop during the constant current operating mode is similar to that during constant voltage operation except that the input to the differential amplifier comparison circuit is obtained from the current sampling resistor(s).

SECTION V MAINTENANCE

5-1 INTRODUCTION

5-2 Upon receipt of the power supply, the performance check (Paragraph 5-10) should be made. This check is suitable for incoming inspection. If a fault is detected in the power supply while making the performance check or during normal operation, proceed to the troubleshooting procedures (Paragraph 5-25). After troubleshooting and repair (Paragraph 5-35), perform any necessary adjustments and calibrations (Paragraph 5-37). Before returning the power supply to normal operation, repeat the performance check to ensure that the fault has been properly corrected and that no other faults exist. Before doing any maintenance checks, turn-on power supply, allow a half-hour warm-up, and read the general information regarding measurement techniques (Paragraph 5-3).

5-3 GENERAL MEASUREMENT TECHNIQUES

5-4 The measuring device must be connected across the sensing leads of the supply or as close to the output terminals as possible when measuring the output impedance, transient response, regulation, or ripple of the power supply in order to achieve valid measurements. A measurement made across the load includes the impedance of the leads to the load and such lead lengths can easily have an impedance several orders of magnitude greater than the supply impedance, thus invalidating the measurement.

5-5 The monitoring device should be connected to the +S and -S terminals (see Figure 3-2) or as shown in Figure 5-1. The performance characteristics should never be measured on the front terminals if the load is connected across the rear terminals. Note that when measurements are made at the front terminals, the monitoring leads are connected at A, not B, as shown in Figure 5-1. Failure to connect the measuring device at A will result in a measurement that includes the resistance of the leads between the output terminals and the point of connection.

5-6 For output current measurements, the current sampling resistor should be a four-terminal resistor. The four terminals are connected as shown in Figure 5-2. In addition, the resistor should be of the low noise, low temperature coefficient (less than 30 ppm/°C) type and should be used at no more than 5% of its rated power so that its temperature rise will be minimized.

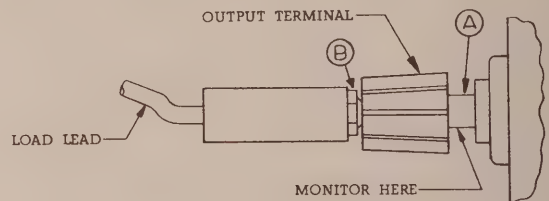


Figure 5-1. Front Panel Terminal Connections

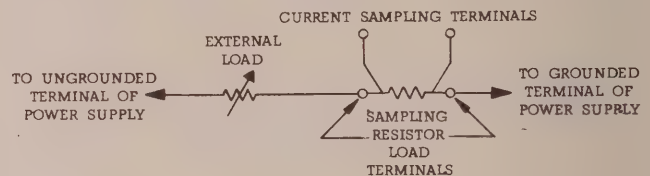


Figure 5-2. Output Current Measurement Technique

5-7 When using an oscilloscope, ground one terminal of the power supply and then ground the case of the oscilloscope to this same point. Make certain that the case is not also grounded by some other means (power line). Connect both oscilloscope input leads to the power supply ground terminal and check that the oscilloscope is not exhibiting a ripple or transient due to ground loops, pick-up, or other means.

5-8 TEST EQUIPMENT REQUIRED

5-9 Table 5-1 lists the test equipment required to perform the various procedures described in this Section.

Table 5-1. Test Equipment Required

Type	Required Characteristics	Use	Recommended Model
Differential Voltmeter	Sensitivity: 1 mv full scale (min.). Input impedance: 10 megohms (min.).	Measure DC voltages; calibration procedures	Ⓢ 3420 (See Note)
Variable Voltage Transformer	Range: 90-130 volts. Equipped with voltmeter accurate within 1 volt.	Vary AC input	-----
AC Voltmeter	Accuracy: 2%. Sensitivity: 1 mv full scale deflection (min.).	Measure AC voltages and ripple	Ⓢ 403 B
Oscilloscope	Sensitivity: 100 μ v/cm. Differential input.	Display transient response waveforms	Ⓢ 140 A plus 1400A plug in.
Oscillator	Range: 5 cps to 600 Kc. Accuracy: 2%.	Impedance checks	Ⓢ 200 CD
DC Voltmeter	Accuracy: 1%. Input resistance: 20,000 ohms/volt (min.).	Measure DC voltages	Ⓢ 412 A
Repetitive Load Switch	Rate: 60 — 400 Hz, 2 μ sec rise and fall time.	Measure transient response	See Figure 5-7
Resistive Loads	Values: See Paragraph 5-14 and Figure 5-4. $\pm 5\%$, 75 watts.	Power supply load resistors	-----
Current Sampling Resistor	Value: See Figure 5-4. 1%, 40 watts, 20ppm, 4-Terminal.	Measure current; calibrate meter	-----
Resistor	1K Ω $\pm 1\%$, 2 watt non-inductive	Measure impedance	-----
Resistor	100 ohms, $\pm 5\%$, 10 watt.	Measure impedance	-----
Resistor	Value: See Paragraph 5-47. $\pm 0.1\%$, 1/2 watt.	Calibrate programming current	-----

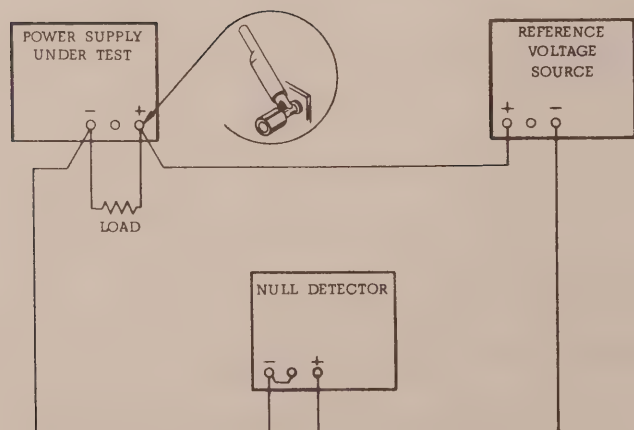
Type	Required Characteristics	Use	Recommended Model
Resistor	Value: See Paragraph 5-50. $\pm 0.1\%$, 1/2 watt.	Calibrate programming current	-----
Capacitor	500 μ f, 50 wvdc	Measure impedance.	-----
Decade Resistance Box	Range: 0-500K. Accuracy: 0.1% plus 1 ohm Make-before-break contacts.	Measure programming coefficients.	-----

NOTE

A satisfactory substitute for a differential voltmeter is to arrange a reference voltage source and null detector as shown in Figure 5-3. The reference voltage source is adjusted so that the voltage difference between the supply being measured and the reference voltage will have the required resolution for the measurement being made. The voltage difference will be a function of the null detector that is used. Examples of satisfactory null detectors are: ~~hp~~ 419 A null detector, a DC coupled oscilloscope utilizing differential input, or a 50 mv meter movement with a 100 division scale. For the latter, a 2 mv change in voltage will result in a meter deflection of four divisions.

CAUTION

Care must be exercised when using an electronic null detector in which one input terminal is grounded to avoid ground loops and circulating currents.



5-10 PERFORMANCE TEST

5-11 The following test can be used as an incoming inspection check and appropriate portions of the test can be repeated either to check the operation of the instrument after repairs or for periodic maintenance tests. The tests are performed using a 115-VAC 60 cps., single phase input power source. If the correct result is not obtained for a particular check, do not adjust any controls; proceed to troubleshooting (Paragraph 5-28).

Figure 5-3. Differential Voltmeter Substitute, Test Setup

5-12 CONSTANT VOLTAGE TESTS

5-13 Rated Output and Meter Accuracy.

5-14 Voltage. Proceed as follows:

a. Connect load resistor across rear output terminals of supply. Resistor value to be as follows:

Model No.	6251A	6253A	6255A	6257A	6258A
Resistance	1.5 Ω	6 Ω	26 Ω	60 Ω	133 Ω

b. Connect differential voltmeter across +S and -S terminals of supply observing correct polarity.

c. Set METER switch to highest voltage range and turn on supply.

d. Adjust VOLTAGE control(s) until front panel meter indicates exactly the maximum rated output voltage.

e. Differential voltmeter should indicate maximum rated output voltage within $\pm 2\%$.

5-15 Current. Proceed as follows:

a. Connect test setup shown in Figure 5-4 leaving switch S1 open.

b. Turn CURRENT controls fully clockwise.

c. Set METER switch to highest current range and turn on supply.

d. Adjust VOLTAGE control(s) until front panel meter indicates exactly the maximum rated output current.

e. Differential voltmeter should read 1.0 ± 0.02 Vdc.

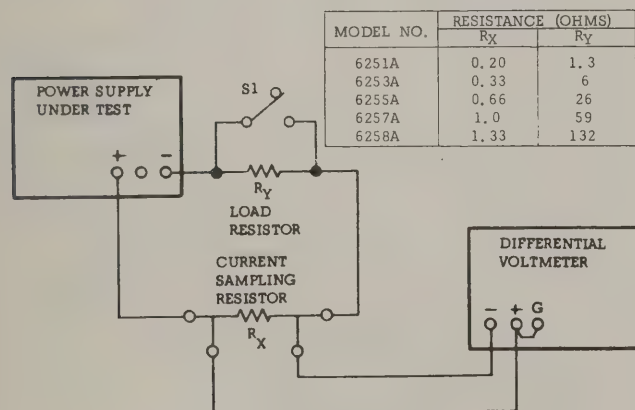


Figure 5-4. Output Current, Test Setup

5-16 Load Regulation. To check constant voltage load regulation, proceed as follows:

a. Connect test setup as shown in Figure 5-5.

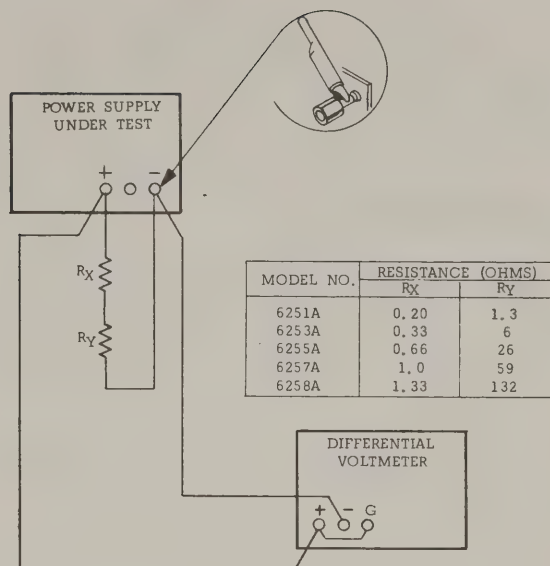


Figure 5-5. Load Regulation, Constant Voltage

b. Turn CURRENT controls fully clockwise.

c. Set METER switch to highest current range and turn on supply.

d. Adjust VOLTAGE control(s) until front panel meter indicates exactly the maximum rated output voltage.

e. Read and record voltage indicated on differential voltmeter.

f. Disconnect load resistors.

g. Reading on differential voltmeter should not vary from reading recorded in step e by more than the following:

Model No.	6251A	6253A	6255A	6257A	6258A
Variation (mvdc)	± 5	± 6	± 6	± 8	± 12

5-17 Line Regulation. To check the line regulation, proceed as follows:

a. Connect variable auto transformer between input power source and power supply power input.

b. Turn CURRENT controls fully clockwise.

c. Connect test setup shown in Figure 5-5.

d. Adjust variable auto transformer for 105 VAC input.

e. Set METER switch to highest voltage range and turn on supply.

f. Adjust VOLTAGE control(s) until front panel meter indicates exactly the maximum rated output voltage.

g. Read and record voltage indicated on differential voltmeter.

h. Adjust variable auto transformer for 125 VAC input.

i. Reading on differential voltmeter should not vary from reading recorded in step g by more than the following:

Model No.	6251A	6253A	6255A	6257A	6258A
Variation (mvdc)	±2.75	±4	±6	±8	±12

5-18 Ripple and Noise. To check the ripple and noise, proceed as follows:

a. Retain test setup used for previous line regulation test except connect AC voltmeter across output terminals as shown in Figure 5-6.

b. Adjust variable auto transformer for 125 VAC input.

c. Set METER switch to highest current range.

d. Turn CURRENT controls fully clockwise and adjust VOLTAGE control(s) until front panel meter indicates exactly the maximum rated output voltage.

e. AC voltmeter should read less than 0.20mvrms.

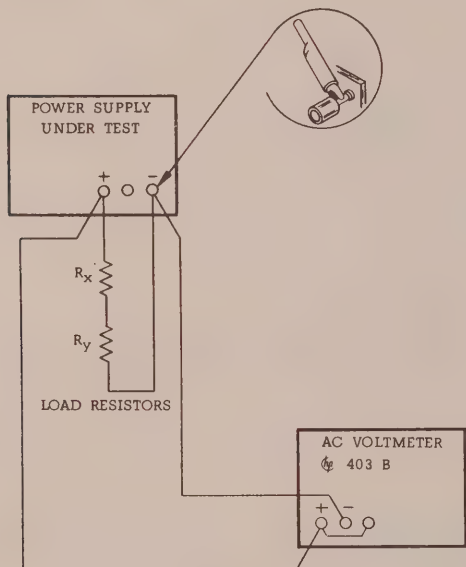


Figure 5-6. Ripple and Noise, Constant Voltage

5-19 Transient Recovery Time. To check the transient recovery time proceed as follows:

a. Connect test setup shown in Figure 5-7.

b. Turn CURRENT controls fully clockwise.

c. Set METER switch to highest current range and turn on supply.

d. Adjust VOLTAGE control(s) until front panel meter indicates exactly the maximum rated output voltage.

e. Close line switch on repetitive load switch setup.

f. Adjust 25K potentiometer until a stable display is obtained on oscilloscope. Waveform should be within the tolerances shown in Figure 5-8 (output should return to within 15 mv of original value in less than 50 microseconds).

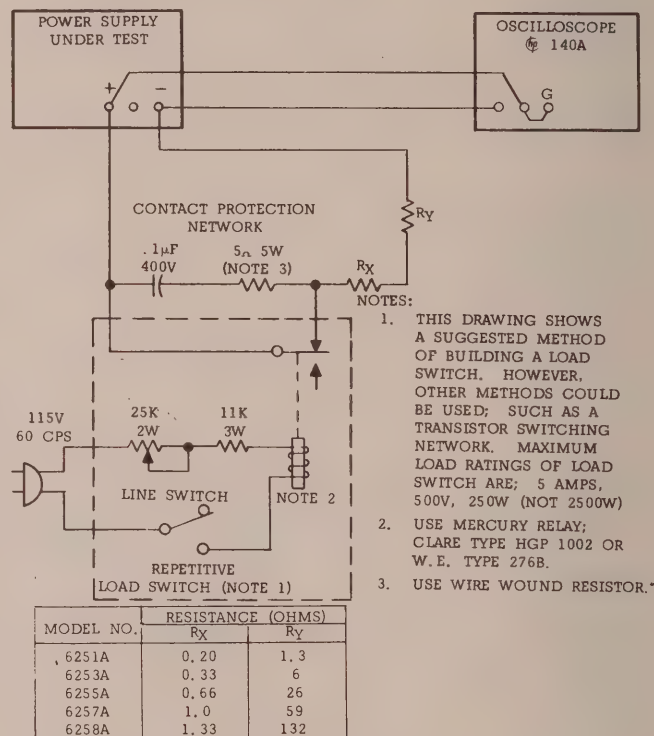


Figure 5-7. Transient Response, Test Setup

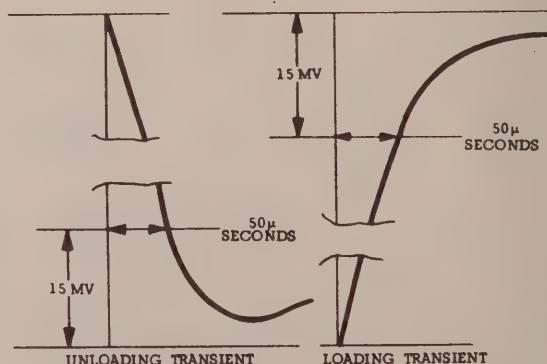


Figure 5-8. Transient Response, Waveforms

5-20 Output Impedance. To check the output impedance, proceed as follows:

- Connect test setup as shown in Figure 5-9.
- Set METER switch to highest voltage range turn CURRENT controls fully clockwise, and turn on supply.
- Adjust VOLTAGE control(s) until front panel meter reads 20 volts (5 volts for Model 6251A supplies).
- Set AMPLITUDE control on Oscillator to 10 volts (E_{in}), and FREQUENCY control to 10 cps.
- Record voltage across output terminals of the power supply (E_o) as indicated on AC voltmeter.
- Calculate the output impedance by the following formula:

$$Z_{out} = \frac{E_o R}{E_{in} - E_o}$$

E_o = rms voltage across power supply output terminals.

$R = 1000$

$E_{in} = 10$ volts

g. The output impedance (Z_{out}) should be less than 0.001 ohm.

h. Using formula of step f, calculate output impedance at frequencies of 100cps, 1Kc, and 500Kc. Values should be less than 0.01 ohm, 0.2 ohm, and 2 ohms, respectively.

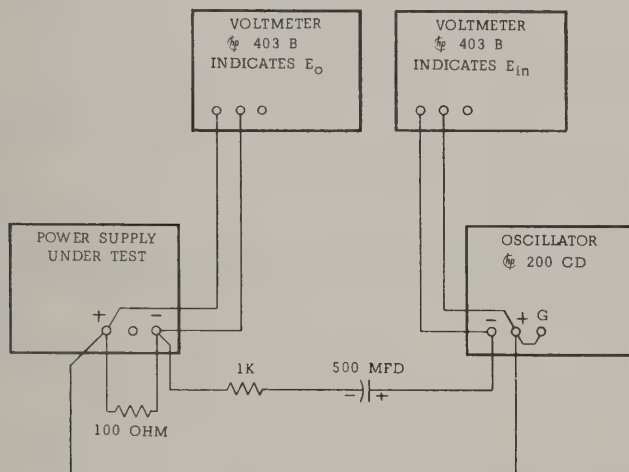


Figure 5-9. Output Impedance, Test Setup

5-21 CONSTANT CURRENT TESTS

5-22 Load Regulation. To check the constant current load regulation, proceed as follows:

- Connect test setup as shown in Figure 5-4.
- Turn VOLTAGE control(s) fully clockwise.

c. Set METER switch to highest current range and turn on supply.

d. Adjust CURRENT control until front panel meter reads exactly the maximum rated output current.

e. Read and record voltage indicated on differential voltmeter.

f. Short out load resistor (R_L) by closing switch S_1 .

g. Reading on differential voltmeter should not vary from reading recorded in step e by more than the following:

Model No.	6251A	6253A	6255A	6257A	6258A
Variation (mvdc)	± 0.150	± 0.183	± 0.265	± 0.350	± 0.433

5-23 Line Regulation. To check the line regulation proceed as follows:

a. Utilize test setup shown in Figure 5-4 leaving switch S_1 open throughout test.

b. Connect variable auto transformer between input power source and power supply power input.

c. Adjust auto transformer for 105 VAC input.

d. Turn VOLTAGE control(s) fully clockwise.

e. Set METER switch to highest current range and turn on supply.

f. Adjust CURRENT controls until front panel meter reads exactly the maximum rated output current.

g. Read and record voltage indicated on differential voltmeter.

h. Adjust variable auto transformer for 125 VAC input.

i. Reading on differential voltmeter should not vary from reading recorded in step g by more than the following:

Model No.	6251A	6253A	6255A	6257A	6258A
Variation (mvdc)	± 0.150	± 0.183	± 0.265	± 0.350	± 0.433

5-24 Ripple and Noise. To check the ripple and noise, proceed as follows:

a. Use test setup shown in Figure 5-4, except connect AC voltmeter across sampling resistor instead of differential voltmeter.

b. Rotate VOLTAGE control(s) fully clockwise.

c. Set METER switch to highest current range and turn on supply.

d. Adjust CURRENT controls until front panel meter indicates exactly the maximum rated output current.

e. Turn range switch on AC voltmeter to 1 mv position.

f. The AC voltmeter should read as follows:

Model No.	6251A	6253A	6255A	6257A	6258A
Reading (mvac)	0.80	0.66	0.33	0.50	0.665

5-25 TROUBLESHOOTING

5-26 Components within Hewlett-Packard power supplies are conservatively operated to provide maximum reliability. In spite of this, parts within a supply may fail. Usually the instrument must be immediately repaired with a minimum of "down time" and a systematic approach as outlined in succeeding paragraphs can greatly simplify and speed up the repair.

5-27 TROUBLE ANALYSIS

5-28 General. Before attempting to trouble shoot this instrument, ensure that the fault is with the instrument and not with an associated circuit. The performance test (Paragraph 5-10) enables this to be determined without having to remove the instrument from the cabinet.

5-29 Once it is determined that the power supply is at fault, check for obvious troubles such as open fuse, a defective power cable, or an input power failure. Next, remove the top and bottom covers (each held by four retaining screws) and inspect for open connections, charred components, etc. If the trouble source cannot be detected by visual inspection, follow the detailed procedure outlined in succeeding paragraphs. Once the defective component has been located (by means of visual inspection or trouble analysis) correct it and re-conduct the performance test. If a component is replaced, refer to the repair and replacement and adjustment and calibration paragraphs in this section.

5-30 A good understanding of the principles of operation is a helpful aid in troubleshooting, and it is recommended that the reader review Section IV of the manual before attempting to troubleshoot the unit in detail. Once the principles of operation are understood, logical application of this knowledge used in conjunction with the normal voltage

readings shown on the schematic and the additional procedures given in the following paragraphs should suffice to isolate a fault to a component or small group of components. The normal voltages shown on the schematic are positioned adjacent to the applicable test points (identified by encircled numbers on the schematic and printed wiring boards). Additional test procedures that will aid in isolating troubles are as follows:

a. Reference circuit check (Paragraph 5-32). This circuit provides critical operating voltages for the supply and faults in the circuit could affect the overall operation in many ways.

b. Feedback loop checks (Paragraph 5-33).

c. Procedures for dealing with common troubles (Paragraph 5-34).

5-31 The test points referred to throughout the following procedures are identified on the schematic diagram by encircled numbers.

5-32 Reference Circuit.

a. Make an ohmmeter check to be certain that neither the positive nor negative output terminal is grounded.

b. Turn front-panel VOLTAGE and CURRENT controls fully clockwise (maximum).

c. Turn-on power supply (no load connected).

d. Proceed as instructed in Table 5-2.

5-33 Feedback Circuit. Generally, malfunction of the feedback circuit is indicated by high or low output voltages. If one of these situations occur, disconnect the load and proceed as instructed in Table 5-3 or Table 5-4.

5-34 Common Troubles. Table 5-5 lists the symptoms, checks, and probable causes for common troubles.

Table 5-2. Reference Circuit Troubleshooting

Step	Meter Common	Meter Positive	Normal Indication	If Indication Abnormal, Take This Action
1	+S	33	$6.2 \pm 0.3\text{vdc}$	Check 12.4 volt bias or VR1
2	31	+S	$6.2 \pm 0.3\text{vdc}$	Check 12.4 volt bias or VR2
3	+S	37	$12.4 \pm 1.0\text{vdc}$	Check Q8, Q9, CR22, CR23, C10, T1

Table 5-3. High Output Voltage Troubleshooting

Step	Measure	Response	Probable Cause
1	Voltage between +S and A6.	0V to +0.8V. More negative than 0V.	a. Open strap between A7 and A8. b. R10 open. Proceed to Step 2.
2	Voltage between +S and 12.	Less positive than +1.5V +1.5V to +2.8V	a. Q1A shorted. b. Q1B open. c. R3 open. Proceed to Step 3.
3	Voltage between +S and 19.	More positive than -0.6V More negative than -0.6V	a. Q3 shorted. b. C5 shorted. Proceed to Step 4.
4	Voltage between 20 and 23.	0V or negative. More positive than 0V.	a. Q6 or Q7 shorted. b. CR11 shorted. a. Q4 or Q5 open. b. R34 or R38 shorted or low resistance.

Table 5-4. Low Output Voltage Troubleshooting

Step	Measure	Response	Probable Cause
1	Disable Q2 by disconnecting CR4.	Normal Output Voltage. Low output voltage.	a. Constant current circuit faulty, check CR4, Q2A, and R16 for short. b. Q2B open. Reconnect CR4 and proceed to Step 2.
2	Voltage between +S and A6.	More negative than 0V. 0V to +0.8V.	a. Open strap A6 - A7. a. Check R10, C1, or C2 for short. b. Proceed to Step 3.
3	Voltage between +S and 12.	More positive than +2.8V +1.5V to +2.8V	a. Q1A open. b. Q1B or R3 shorted. Proceed to Step 4.
4	Voltage between +S and 19.	More negative than -0.6V More positive than -0.6V	a. Q3 open. b. R33 shorted or low. a. Q5 shorted. b. Proceed to Step 5.
5	Voltage between 20 and 23.	More negative than 0V. More positive than 0V.	a. R34 open. b. Q4 shorted. a. Q6 or Q7 open.

Table 5-5. Common Troubles

Symptom	Checks and Probable Causes
High ripple	a. Check operating setup for ground loops. b. If output floating, connect 1 μ f capacitor between output and ground. c. Ensure that supply is not crossing over to constant current mode under loaded conditions. Check for low voltage across C14 or Q6.
Poor line regulation	a. Check reference circuit (Paragraph 5-32). b. Check reference circuit adjustment (Paragraph 5-51).
Poor load regulation (Constant Voltage)	a. Measurement technique. (Paragraph 5-16.) b. Check reference circuit (Paragraph 5-32) and adjustment (Paragraph 5-51). c. Ensure that supply is not going into current limit. Check constant current input circuit.
Poor load regulation (Constant Current)	a. Check reference circuit (Paragraph 5-32) and adjustment (Paragraph 5-51). b. C19, C20, and CR34 leaky. c. Check clamp circuit Q10, CR30, CR31 and CR32. d. Ensure that supply is not crossing over to constant voltage operation. Check constant voltage input circuit.
Oscillates (Constant Voltage / Constant Current)	a. Check C5 for open, adjustment of R30 (Paragraph 5-55). b. Check R20, C3 in constant current input circuit.
Poor Stability (Constant Voltage)	a. Check ± 6.2 Vdc reference voltages (Paragraph 5-32). b. Noisy programming resistor R10. c. CR1, CR2 leaky. d. Check R1, R12, R13, C2 for noise or drift. e. Stage Q1 defective.
Poor Stability (Constant Current)	a. Check ± 6.2 Vdc reference voltages (Paragraph 5-32). b. Noisy programming resistor R16. c. CR5, CR34, C20, C3 leaky. d. Check R18, R19, R20, R21, R54, for noise or drift. e. Stage Q2 defective.

5-35 REPAIR AND REPLACEMENT

5-36 Before servicing a printed wiring board, refer to Figure 5-10. Section VI of this manual contains a list of replaceable parts. Before replacing a semiconductor device, refer to Table 5-6 which lists

the special characteristics of selected semiconductors. If the device to be replaced is not listed in Table 5-6, the standard manufacturers part number listed in Section VI is applicable. After replacing a semiconductor device, refer to Table 5-7 for checks and adjustments that may be necessary.

Table 5-6. Selected Semiconductor Characteristics

Reference Designator	Characteristics	Φ Stock No.	Suggested Replacement
Q1,2	Matched differential amplifier. NPN Si Planar. 70 (min.) hFE $i_c = 1$ ma. VCE = 5V. $I_{co} 0.01\mu$ a @ Vcbo = 5V.	1854-0229	2N2917 G.E.
Q4	PNP $I_{cex} = 0.1$ ma (max) @ VCE = 90V, VBE = 1.5V	1853-0040	2N3741 Motorola

Table 5-6. Selected Semiconductor Characteristics (Continued)

Reference Designator	Characteristics	Stock No.	Suggested Replacement
Q6,7	NPN Power $h_{FE} = 35$ (min.) @ $I = 1A$, $V_{CE} = 4V$. V_{CE} (sat.) = 1V max @ $I_C = 1A$; $I_B = 0.1A$.	1854-0239	2N3442 R. C. A.
CR1-5,19,20,30,32	Si. rectifier, 200ma, 200prv	1901-0033	1N485B Sylvania
CR7-9, 12, 31	Si. diode, 2.4V @ 100ma	1901-0460	1N4830 G. E.
CR17,22-25	Si. rectifier, 500ma, 200prv	1901-0026	1N3253 R. C. A.

Table 5-7. Checks and Adjustments After Replacement of Semiconductor Devices

Reference	Function	Check	Adjust
Q1	Constant voltage differential amplifier	Constant voltage (CV) line and load regulation. Zero volt output.	R6 or R8
Q2	Constant current differential amplifier	Constant current (CC) line and load regulation. Zero current output.	R25 or R28
Q3, Q4(Q5)	Mixer and error amplifier(s)	CV/CC load regulation. CV transient response.	R30
Q6, Q7	Series regulator	CV/CC load regulation.	
Q8, Q9	Reference regulator	Reference circuit line regulation.	R46
Q10	Clamp circuit	CC load regulation.	
Q11-Q15	Meter circuit	Meter zero. Voltmeter/ammeter tracking.	R63,R72, R56
CR1, CR2	Limiting diodes	CV load regulation.	
CR3,CR4,CR5	OR-gate diodes and limiting diode	CV/CC load regulation.	
CR8(CR9)	Forward bias regulator	Voltage across each diode 2.0 to 2.4 volts.	
CR22-CR29	Rectifier diodes	Voltage across appropriate filter capacitor.	
CR34	Protection diode	Output voltage	
VR1	Positive reference voltage	Positive reference voltage (+6.2V).	
VR2	Negative reference voltage	Negative reference voltage (-6.2V).	

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

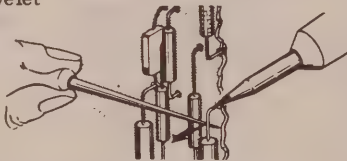
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

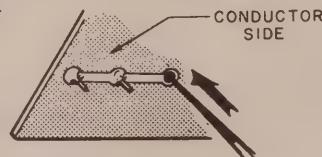
WARNING: If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.

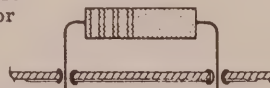


2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole.

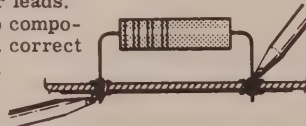
If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.



3. Bend clean tinned lead on new part and carefully insert through eyelets or holes in board.

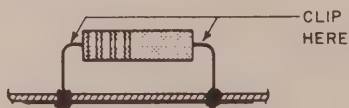


4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

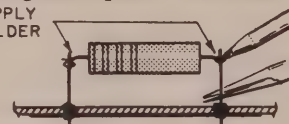


In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.



2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.



This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

Figure 5-10. Servicing Printed Wiring Boards

5-37 ADJUSTMENT AND CALIBRATION

5-38 Adjustment and calibration may be required after performance testing, troubleshooting, or repair

and replacement. Perform only those adjustments that affect the operation of the faulty circuit and no others. Table 5-8 summarizes the adjustments and calibrations contained in the following paragraphs.

Table 5-8. Calibration Adjustment Summary

Adjustment or Calibration	Paragraph	Control Device
Meter Zero	5-39	Pointer
Voltmeter Tracking	5-41	R63 and R72
Ammeter Tracking	5-43	R56
"Zero" Volt Output	5-46	R6 or R8
"Voltage" Programming Current	5-47	R13
"Zero" Current Output	5-49	R25 or R28
"Current" Programming Current	5-50	R19
Reference Circuit Line Voltage Adjustment	5-52	R46
Negative Reference Load Adjustment	5-53	Replace VR2
Positive Reference Load Adjustment	5-54	Replace VR1
Transient Response	5-55	R30

5-39 METER ZERO

5-40 Proceed as follows to zero meter:

a. Turn off instrument (after it has reached normal operating temperature) and allow 30 seconds for all capacitors to discharge.

b. Insert sharp pointed object (pen point or awl) into the small indentation near top of round black plastic disc located directly below meter face.

c. Rotate plastic disc clockwise (cw) until meter reads zero, then rotate ccw slightly in order to free adjustment screw from meter suspension. If pointer moves, repeat steps b and c.

5-41 VOLTMETER TRACKING

5-42. To calibrate voltmeter tracking, proceed as follows:

a. To electrically zero meter, set METER switch to highest current position and, with supply off and no load connected, adjust R63 until front panel meter reads zero.

b. Connect differential voltmeter across supply, observing correct polarity.

c. Set METER switch to highest voltage range and turn on supply. Adjust VOLTAGE control until differential voltmeter reads exactly the maximum rated output voltage.

d. Adjust R72 until front panel meter also indicates maximum rated output voltage.

5-43 AMMETER TRACKING

5-44 To calibrate ammeter tracking proceed as follows:

a. Connect test setup shown on Figure 5-4 leaving switch S1 open.

b. Turn VOLTAGE control fully clockwise and set METER switch to highest current range.

c. Turn on supply and adjust CURRENT controls until differential voltmeter reads 1.0 Vdc.

d. Adjust R56 until front panel meter indicates exactly the maximum rated output current.

5-45 CONSTANT VOLTAGE PROGRAMMING CURRENT

5-46 To calibrate the zero volt programming accuracy, proceed as follows:

- Connect differential voltmeter between +S and -S terminals.
- Short out voltage controls by connecting jumper between terminals A6 and -S.
- Rotate CURRENT controls fully clockwise and turn on supply.
- Observe reading on differential voltmeter.
- If it is more positive than 0 volts, shunt resistor R6 with decade resistance box.
- Adjust decade resistance until differential voltmeter reads zero, then shunt R6 with resistance value equal to that of the decade resistance.
- If reading of step d is more negative than 0 volts, shunt resistor R8 with the decade resistance box.
- Adjust decade resistance until differential voltmeter reads zero then shunt R8 with resistance value equal to that of the decade box.

5-47 To calibrate the constant voltage programming current, proceed as follows:

- Connect a 0.1%, $\frac{1}{2}$ watt resistor between terminals -S and A6 on rear barrier strip. Resistor value to be as follows:

Model No.	6251A	6253A	6255A	6257A	6258A
Resistance	1.5K Ω	4K Ω	8K Ω	18K Ω	30K Ω
- Disconnect jumper between A7 and A8 (leaving A6 and A7 jumpered) on rear terminal barrier strip.
- Connect a decade resistance in place of R13.
- Connect a differential voltmeter between +S and -S and turn on supply.
- Adjust decade resistance box so that differential voltmeter indicates maximum rated output voltage within the following tolerances:

Model No.	6251A	6253A	6255A	6257A	6258A
Tolerance (Vdc)	± 0.15	± 0.4	± 0.8	± 1.2	± 2.0
- Replace decade resistance with resistor of appropriate value in R13 position.

5-48 CONSTANT CURRENT PROGRAMMING CURRENT

5-49 To calibrate the zero current programming accuracy proceed as follows:

- Connect differential voltmeter between +S and -S terminals.
- Short out current controls by connecting jumper between terminals A1 and A5.
- Rotate VOLTAGE control(s) fully clockwise and turn on supply.
- Observe reading on differential voltmeter.

- If it is more positive than 0 volts, shunt resistor R25 with a decade resistance box.
- Adjust decade resistance until differential voltmeter reads zero, then shunt R25 with resistance value equal to that of decade resistance.
- If reading of step d is more negative than 0 volts, shunt resistor R28 with decade resistance.
- Adjust decade resistance until differential voltmeter reads zero, then shunt R28 with resistance value equal to that of decade box.

5-50 To calibrate the constant current programming current, proceed as follows:

- Connect power supply as shown in Figure 5-4.
- Remove strap between A3 and A4 (leaving A4 and A5 jumpered).
- Connect a 0.1%, $\frac{1}{2}$ watt resistor between A1 and A5. Resistor value to be as follows:

Model No.	6251A	6253A	6255A	6257A	6258A
Resistance	1K Ω	1.5K Ω	750 Ω	1K Ω	750 Ω
- Connect decade resistance box in place of R19.
- Set METER switch to highest current range and turn on supply.
- Adjust the decade resistance so that the differential voltmeter indicates 1.0 ± 0.02 Vdc.
- Replace decade resistance with appropriate value resistor in R19 position.

5-51 REFERENCE CIRCUIT ADJUSTMENTS

5-52 Line Regulation. To adjust the line regulation, capabilities of the instrument proceed as follows:

- Connect the differential voltmeter between +S (common) and 33 (positive).
- Connect variable voltage transformer between supply and input power source.
- Adjust line to 105 VAC.
- Connect decade resistance in place of R46.
- Turn on supply and adjust VOLTAGE control(s) for maximum rated output voltage.
- Adjust decade resistance so that voltage indicated by differential voltmeter does not change more than the following as input line voltage is varied from 105 to 125 VAC:

Model No.	6251A	6253A	6255A	6257A	6258A
Variation (mvdc)	1.24	0.946	0.806	0.750	0.701
- Replace decade resistance with appropriate value resistor in R46 position.

5-53 Load Regulation, -6.2 Volt Reference. To check the load regulation of the -6.2 volt reference voltage, proceed as follows:

- Connect test setup as shown in Figure 5-5, except connect differential voltmeter between +S and 31 (across VR2).

- b. Repeat steps b through f of Paragraph 5-16.
- c. The differential voltmeter reading should not vary by more than 0.2 mvdc.
- d. If variation is greater than 0.2 mvdc, replace VR2 and repeat preceding steps.

5-54 Load Regulation, +6.2 Volt Reference. To check the load regulation of the +6.2 volt reference voltage, proceed as follows:

- a. Utilize test setup shown in Figure 5-5, expect connect differential voltmeter between 33 and +S (across VR1).
- b. Repeat steps b through f of Paragraph 5-16.

- c. The differential voltmeter reading should not vary by more than 0.2 mvdc.
- d. If it does, replace VR1 and repeat preceding steps.

5-55 CONSTANT VOLTAGE TRANSIENT RESPONSE

5-56 To adjust the transient response, proceed as follows:

- a. Connect test setup as shown in Figure 5-7.
- b. Repeat steps a through e as outlined in Paragraph 5-19.
- c. Adjust R30 so that the transient response is as shown in Figure 5-8.

SECTION VI REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts.

6-3 Table 6-1 lists parts in the alpha-numerical order of the reference designators and provides the following information:

- a. Description (See list of abbreviations below).
- b. Total quantity used in the instrument.
- c. Manufacturer's name and part number.
- d. The Manufacturer's code number as listed in the Federal Supply Code for Manufacturers H4-1.
- e. The ϕ Stock Number.
- f. The recommended spare parts quantity for complete maintenance of one instrument during one year of isolated service. (Column RS)

6-4 ORDERING INFORMATION

6-5 To order a replacement part, address order or inquiry to your local Hewlett-Packard field office (see lists at rear of this manual for addresses).

6-6 Specify the following information for each part:

- a. Model and complete serial number of instrument.
- b. Hewlett-Packard stock number.
- c. Circuit reference designator.
- d. Description.

6-7 To order a part not listed in the tables, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A = assembly	Q = transistor
B = motor	R = resistor
C = capacitor	RT = thermistor
CR = diode	S = switch
DS = device signaling (lamp)	T = transformer
E = misc. electronic part	V = vacuum tube, neon bulb, photocell, etc.
F = fuse	X = socket
J = jack	XF = fuseholder
K = relay	XDS = lampholder
L = inductor	Z = network
M = meter	
P = plug	

ABBREVIATIONS

a = amperes	obd = order by description
c = carbon	p = peak
cer = ceramic	pc = printed circuit board
coef = coefficient	pf = picofarads = 10^{-12} farads
com = common	pp = peak-to-peak
comp = composition	ppm = parts per million
conn = connection	pos = position(s)
crt = cathode-ray tube	poly = polystyrene
dep = deposited	pot = potentiometer
elect = electrolytic	prv = peak reverse voltage
encap = encapsulated	rect = rectifier
f = farads	rot = rotary
fxd = fixed	rms = root-mean-square square
GE = germanium	s-b = slow-blow
grd = ground(ed)	sect = section(s)
h = henries	Si = silicon
Hg = mercury	sil = silver
imp = impregnated	sl = slide
ins = insulation(ed)	td = time delay
lin = linear taper	TiO ₂ = titanium dioxide
log = logarithmic taper	tog = toggle
m = milli = 10^{-3}	tol = tolerance
M = megohms	trim = trimmer
ma = milliamperes	tw = traveling wave tube
μ = micro = 10^{-6}	var = variable
mfr = manufacturer	w/ = with
mtg = mounting	W = watts
my = mylar	w/o = without
NC = normally closed	cmo = cabinet mount only
Ne = neon	
NO = normally open	
nsr = not separately replaceable	
K = kilo = 1000	

MANUFACTURERS

AB	Allen-Bradley	Mot	Motorola, Inc.
B	Bendix Corp.	RCA	Radio Corp. of America
Beede	Beede Elec. Instr. Co., Inc.	Reliance	Reliance Mica Corp.
Buss	Bussman Mfg.	Mica	U.S. Mica Corp.
Carling	Carling Elec.	Semcor	Sloan Co.
CTS	CTS Corp.	Sloan	Sprague Elec.
Elco	Elco Corp.	Sprague	Superior Elec.
GE	General Elec.	Superior	Sylvania Elec. Products, Inc.
GI	General Instr.	Sylv.	Texas Instr.
HH	Hardwick-Hindle Co.	TI	Ward Leonard
Kulka	Kulka Electric	WL	

6-8 CODE LIST OF MANUFACTURERS (Sheet 1 of 3)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS
00656	Aerovox Corp.	New Bedford, Mass.	06555	Beede Electrical Instrument Co, Inc.	Penacook, N. H.
00853	Sangamo Electric Company,		06751	Nuclear Corp. of America, Inc.,	
	Ordill Division (Capacitors)	Marion, Ill.		U. S. Semcor Div.	Phoenix, Arizona
01121	Allen Bradley Co.	Milwaukee, Wis.	06812	Torrington Mfg. Co., West Div.	
01255	Litton Industries, Inc.	Beverly Hills, Calif.		Van Nuys, Calif.	
01281	TRW Semiconductors, Inc.	Lawndale, Calif.	07137	Transistor Electronics Corp.	Minneapolis, Minn.
01295	Texas Instruments, Inc. Semiconductor- Components Division	Dallas, Texas	07138	Westinghouse Electric Corp.	
01561	Chassi-Trak Corp.	Indianapolis, Ind.		Electronic Tube Div.	Elmira, N. Y.
01686	RCL Electronics, Inc.	Manchester, N. H.	07263	Fairchild Semiconductor Div. of Fairchild Camera and Instrument Corp.	Mountain View, Calif.
01930	Amerock Corp.	Rockford, Ill.	07716	International Resistance Co.	Burlington, Iowa
02114	Ferroxcube Corp. of Amerfca	Saugerties, N. Y.	07910	Continental Device Corp.	Hawthorne, Calif.
02660	Amphenol-Borg Electronics Corp.	Maywood, Ill.	07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
02735	Radio Corp. of America, Commercial Receiving Tube and Semiconductor Div.	Somerville, N. J.	08530	Reliance Mica Corp.	Brooklyn, N. Y.
03508	G. E. Semiconductor Products Dept.	Syracuse, N. Y.	08717	Sloan Company	Sun Valley, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.	11236	CTS of Berne, Inc.	Berne, Ind.
03888	Pyrofilm Resistor Co.	Cedar Knolls, N. J.	11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.	11711	General Instrument Corp., Semiconductor Prod. Group, Rectifier Div.	Newark, N. J.
04062	Elmenco Products Co.	New York, N. Y.	12697	Clarostat Mfg. Co.	Dover, N. H.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.	14493	Hewlett-Packard Co., Loveland Division	Loveland, Colo.
04651	Sylvania Electric Products, Inc. Microwave Device Div.	Mountain View, Calif.	14655	Cornell-Dubilier Elec. Corp.	Newark, N. J.
04713	Motorola, Inc., Semiconductor Products Division	Phoenix, Arizona	14936	General Instrument Corp., Semiconductor Prod. Group, Semiconductor Div.	Hicksville, L. I., N. Y.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.	15909	Daven Div. of Thos. Edison Industries, McGraw Edison Co.	Livingston, N. J.
05347	Ultronix, Inc.	Grand Junction, Colo.	16299	Corning Glass Works, Electronic Components Div.	Raleigh, N. C.
06486	North American Electronics, Inc.	Lynn, Mass.	16758	Delco Radio Div. of General Motors Corp.	Kokomo, Ind.
06540	Amatom Electronic Hardware Co, Inc.	New Rochelle, N. Y.	18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
			19315	The Bendix Corp., Eclipse Pioneer Div.	Teterboro, N. J.

FROM: F. S. C. Handbook Supplements
H4-1 October, 1965.
H4-2 October, 1965.

6-8 CODE LIST OF MANUFACTURERS (Sheet 2 of 3) CONT'D.

CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS
19701	Electra Mfg. Co.	Independence, Mo.	73293	Hughes Components Division of Hughes Aircraft Co.	Newport Beach, Calif.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.	73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
22229	Union Carbide Corp., Linde Div., Kemet Dept.	Mountain View, Calif.	73506	Bradley Semiconductor Corp.	New Haven, Conn.
24446	General Electric Co.	Schenectady, N.Y.	73559	Carling Electric, Inc.	Hartford, Conn.
24455	General Electric Co., Lamp Division	Nela Park, Cleveland, Ohio	73734	Federal Screw Products, Inc.	Chicago, Ill.
24655	General Radio Co.	West Concord, Mass.	73978	Hardwick Hindle Co.,	
28480	Hewlett-Packard Co.	Palo Alto, Calif.		Memcor Components Div.	Huntington, Ind.
28520	Heyman Mfg. Co.	Kenilworth, N.J.	74193	Heineman Electric Co.	Trenton, N.J.
33173	G. E., Tube Dept.	Owensboro, Ky.	74545	Harvey Hubbel, Inc.	Bridgeport, Conn.
35434	Lectrohm, Inc.	Chicago, Ill.	74868	FXR Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
37942	P.R. Mallory & Co, Inc.	Indianapolis, Ind.	75042	International Resistance Co.	Philadelphia, Pa.
42190	Muter Co.	Chicago, Ill.	75173	Howard B. Jones Div., of Cinch Mfg. Corp. (Use 71785)	New York, N.Y.
44655	Ohmite Manufacturing Co.	Skokie, Ill.	75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
47904	Polaroid Corporation	Cambridge, Mass.	75915	Littlefuse, Inc.	Des Plaines, Ill.
49956	Raytheon Mfg. Co., Microwave and Power Tube Div.	Waltham, Mass.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.
55026	Simpson Electric Co.	Chicago, Ill.	77068	Bendix Corp., Bendix-Pacific Div.	No. Hollywood, Calif.
56289	Sprague Electric Co.	North Adams, Mass.	77221	Phaotron Instrument and Electronic Co.	South Pasadena, Calif.
58474	Superior Electric Co.	Bristol, Conn.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
60437	Jas. H. Power Iron Works	Providence, R.I.	77342	American Machine and Foundry, Potter and Brumfield Div.	Princeton, Ind.
61637	Union Carbide Corp.	New York, N.Y.	77630	TRW Electronics, Components Div.	Camden, N.J.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.	77764	Resistance Products Co.	Harrisburg, Pa.
70563	Amperite Co., Inc.	Union City, N.J.	78189	Shakeproof Div. of Illinois Tool Works	Elgin, Ill.
70903	Belden Mfg. Co.	Chicago, Ill.	78488	Stackpole Carbon Co.	St. Marys, Pa.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
71450	GTS Corporation	Elkhart, Ind.	79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
71468	I. T. T. Cannon Electric Co.	Los Angeles, Calif.	80031	Mepco Div. of Sessions Clock Co.	Morristown, N.J.
71590	Centralab Div. of Globe Union, Inc.	Milwaukee, Wis.	80294	Bourns, Inc.	Riverside, Calif.
71700	The Cornish Wire Co.	New York, N.Y.	81453	Raytheon Mfg. Co., Industrial Components Operation, Component Div.	Newton, Mass.
71744	Chicago Miniature Lamp Works	Chicago, Ill.	81483	International Rectifier Corp.	El Segundo, Calif.
71785	Cinch Mfg. Co.	Chicago, Ill.			
71984	Dow Corning Corp.	Midland, Mich.			
72619	Dialight Corporation	Brooklyn, N.Y.			
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.			
72765	Drake Mfg. Co.	Chicago, Ill.			
72982	Erie Technological Products, Inc.	Erie, Pa.			
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.			

FROM: F. S. C. Handbook Supplements
H4-1 October, 1965.
H4-2 October, 1965.

THE FOLLOWING H-P VENDORS HAVE NO NUMBERS
ASSIGNED IN THE LATEST SUPPLEMENT TO THE
FEDERAL SUPPLY CODE FOR MANUFACTURERS
HANDBOOK.

0000 Cooltron . Oakland, Calif.

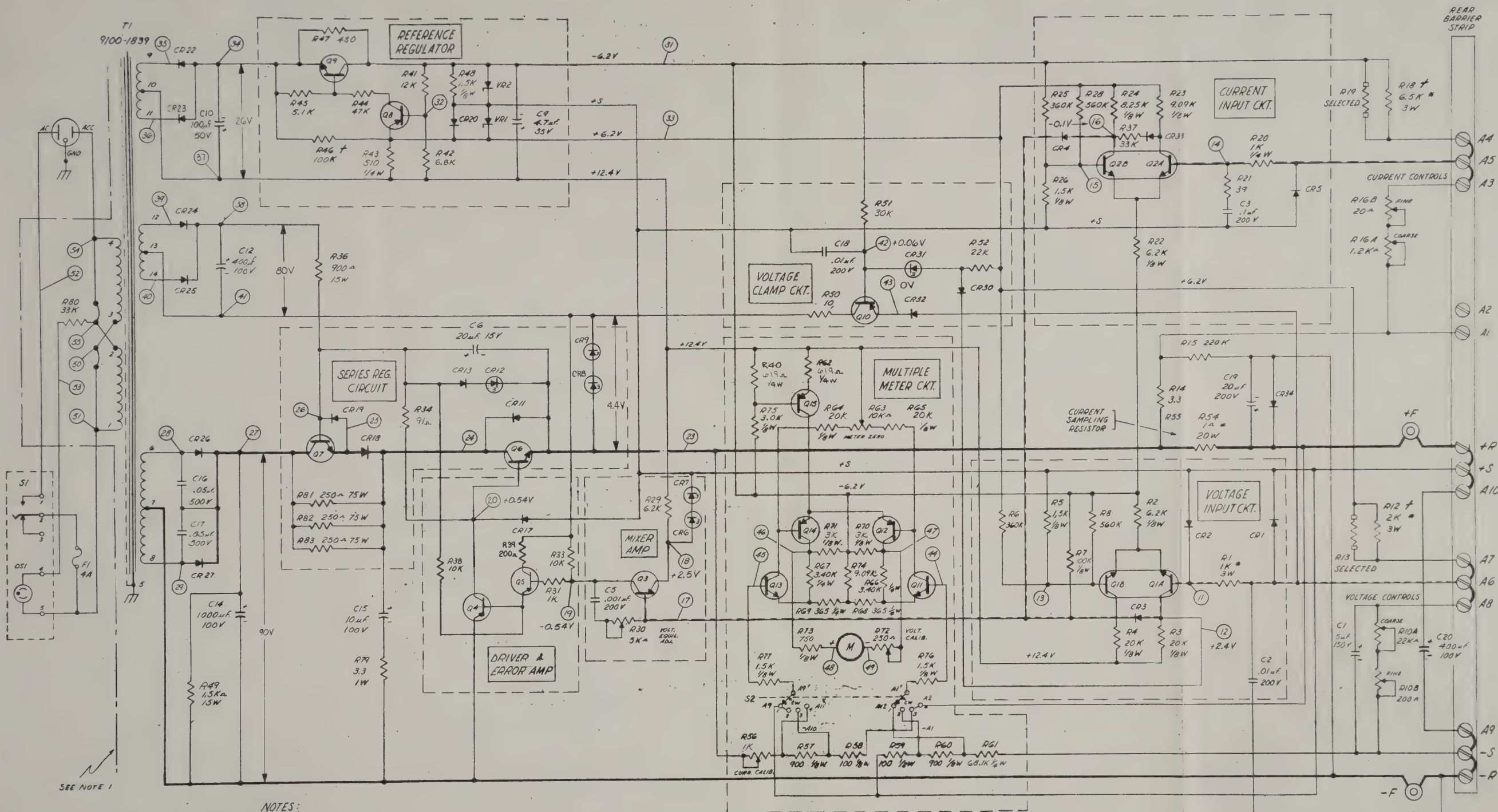
H4-1 October, 1965.
H4-2 October, 1965.

Reference Designator	Description	Quantity	Mfr. Part # or Type	Mfr.	Mfr. Code	Stock No.	RS
C1	fxd, elect 5 μ f 150vdc	2	40 D 505 F150 DC4	Sprague	56289	0180-1841	1
C2,18	fxd, film .01 μ f 200vdc	4	192P10392	Sprague	56289	0160-0161	1
C3	fxd, film 0.1 μ f 200vdc	2	192P10492	Sprague	56289	0160-0168	1
C4,7,8,11,13	NOT ASSIGNED	-	-	-	-	-	-
C5	fxd, film .001 μ f 200vdc	2	192P10292	Sprague	56289	0160-0153	1
C6	fxd, elect 20 μ f 15vdc	2	30 D 206G 015BB4	Sprague	56289	0180-0300	1
C9	fxd, elect 4.7 μ f 35vdc	2	150D475X9035B2	Sprague	56289	0180-0100	1
C10	fxd, elect 100 μ f 50vdc	2	D33218	HLAB	09182	0180-1852	1
C12,20	fxd, elect 400 μ f 100vdc	4	D40713	HLAB	09182	0180-1887	1
C14	fxd, elect 1000 μ f 100vdc	2	D40017	HLAB	09182	0180-1881	1
C15	fxd, elect 10 μ f 100vdc	2	30D106G100DD4	Sprague	56289	0180-0091	1
C16,17	fxd, ceramic .05 μ f 500V	4	33C17A	Sprague	56289	0150-0052	1
C19	fxd, elect 20 μ f 200vdc	2	34D206F200FJ4	Sprague	56289	0180-0367	1
CR1-5,19,20,30,32	Rect. si. 200ma 200prv	18		HLAB	09182	1901-0033	8
CR6,13,33	Rect. si. 200ma 15prv	6		HLAB	09182	1901-0461	6
CR7-9,12,31	Diode, si. 2.4V @ 100ma	10		HLAB	09182	1901-0460	6
CR10,14-16,21,28,29,35	NOT ASSIGNED	-	-	-	-	-	-
CR11,18,26,27,34	Rect. si. 3A 200prv	10	MR1032B	Motorola	04713	1901-0416	6
CR17,22-25	Rect. si. 500ma 200prv	10	1N3253	R. C. A.	02735	1901-0026	6
DS1	Lamp neon part of si ass'y	Ref	AIC-100	Oak	87034	1450-0106	2
F1	Fuse cartridge 4A @250V 3AG	1	312004	Littlefuse	75915	2110-0027	5
Q1,2	SS NPN diff. amp. si.	4		HLAB	09182	1854-0229	4
Q3,5,8,10,12,14,15	SS PNP si. 2N3906	14	MPS 6517	Motorola	04713	1853-0065	7
Q4	SS PNP si. 2N3740	2		HLAB	09182	1853-0040	2
Q6,7	Power NPN si.	4		HLAB	09182	1854-0239	4
Q9,11,13	SS NPN si.	6	2N3391	G. E.	03508	1854-0071	6
R1	fxd, ww 1K Ω \pm 5% 3w	2	242E1025	Sprague	56289	0813-0001	1
R2,22	fxd, met. film 6.2K \pm 1% 1/8w	4	Type CEA T-O	I. R. C.	07716	0698-5087	1
R3,4,64,65	fxd, met. film 20K Ω \pm 1% 1/8w	8	Type CEA T-O	I. R. C.	07716	0757-0449	2
R5,26,48,76,77	fxd, met. film 1.5K Ω \pm 1% 1/8w	10	Type CEA T-O	I. R. C.	07716	0757-0427	2
R6,25	fxd, comp 360K Ω \pm 5% 1/2w	4	EB-3645	A. B.	01121	0686-3645	1
R7	fxd, met. film 100K Ω \pm 1% 1/8w	2	Type CEA T00	I. R. C.	07716	0751-0465	1
R8,28	fxd, comp 560K Ω \pm 5% 1/2w	4	EB-5645	A. B.	01121	0686-5645	1
R9,11,17,27,32,35,53,55,78	NOT ASSIGNED	-	-	-	-	-	-
R10	var. ww DUAL 22K - 200 Ω	2		HLAB	09182	2100-0998	1
R12	fxd, ww 2K Ω \pm 5% 3w	2	242 E 2025	Sprague	56289	0811-1806	1
R13,19	fxd, comp SELECTED \pm 5% 1/2w	4	Type EB	A. B.	01121		1
R14	fxd, comp 3.3 Ω \pm 5% 1/2w	2	EB-0335	A. B.	01121	0686-0335	1
R15	fxd, comp 220K Ω \pm 5% 1/2w	2	EB-2245	A. B.	01121	0686-2245	1
R16	var. ww DUAL 1.2K - 20 Ω	2		HLAB	09182	2100-1803	1
R18	fxd, ww 6.5K Ω \pm 5% 3w	2	242E6525	Sprague	56289	0811-1814	1

* installed

Reference Designator	Description	Quantity	Mfr. Part # or Type	Mfr.	Mfr. Code	Stock No.	RS
R20	fxd, met. film 1K Ω \pm 1% 1/4w	2	Type CEB T-O	I. R. C.	07716	0757-0338	1
R21	fxd, comp 39 Ω \pm 5% 1/2w	2	EB-3905	A. B.	01121	0686-3905	1
R23,74	fxd, met. film 9.09K Ω \pm 1% 1/8w	4	Type CEA T-O	I. R. C.	07716	0757-0288	1
R24	fxd, met. film 8.25K Ω \pm 1% 1/8w	2	Type CEA T-O	I. R. C.	07716	0757-0441	1
R29	fxd, comp 6.2K Ω \pm 5% 1/2w	2	EB-6225	A. B.	01121	0686-6225	1
R30	var. ww 5K Ω (Modify)	2	Type 110-F4	C. T. S.	11236	2100-1824	1
R31	fxd, comp 1K Ω \pm 5% 1/2w	2	EB-1025	A. B.	01121	0686-1025	1
R33,38	fxd, comp 10K Ω \pm 5% 1/2w	4	EB-1035	A. B.	01121	0686-1035	1
R34	fxd, comp 91 Ω \pm 5% 1/2w	2	EB-9105	A. B.	01121	0686-9105	1
R36	fxd, ww 900 Ω \pm 5% 15w	2		HLAB	09182	0811-0957	1
R37,80	fxd, comp 33K Ω \pm 5% 1/2w	4	EB-3335	A. B.	01121	0686-3335	1
R39	fxd, comp 200 Ω \pm 5% 1/2w	2	EB-2015	A. B.	01121	0686-2015	1
R40,62	fxd, met. film 619 Ω \pm 1% 1/4w	4	Type CEB T-O	I. R. C.	07716	0757-0728	1
R41	fxd, comp 12K Ω \pm 5% 1/2w	2	EB-1235	A. B.	01121	0686-1235	1
R42	fxd, comp 6.8K Ω \pm 5% 1/2w	2	EB-6825	A. B.	01121	0686-6825	1
R43	fxd, met. film 510 Ω \pm 1% 1/4w	2	Type CEB T-O	I. R. C.	07716	0698-5145	1
R44	fxd, comp 47K Ω \pm 5% 1/2w	2	EB-4735	A. B.	01121	0686-4735	1
R45	fxd, comp 5.1K Ω \pm 5% 1/2w	2	EB-5125	A. B.	01121	0686-5125	1
R46	fxd, comp 100K Ω \pm 5% 1/2w	2	EB-1045	A. B.	01121	0686-1045	1
R47	fxd, comp 430 Ω \pm 5% 1/2w	2	EB-4315	A. B.	01121	0686-4315	1
R49	fxd. ww 1.5K Ω \pm 5% 15w	2		HLAB	09182	0811-1824	1
R50	fxd, comp 10 Ω \pm 5% 1/2w	2	EB-1005	A. B.	01121	0686-1005	1
R51	fxd, comp 30K Ω \pm 5% 1/2w	2	EB-3035	A. B.	01121	0686-3035	1
R52	fxd, comp 22K Ω \pm 5% 1/2w	2	EB-2235	A. B.	01121	0686-2235	1
R54	fxd. ww 1 Ω C. T. \pm 5% 20w	2		HLAB	09182	0811-1819	1
R56	var. ww 1K Ω (Modify)	2	Type 110-F4	C. T. S.	11236	2100-0391	1
R57,60	fxd, met. film 900 Ω \pm 1% 1/8w	4	Type CEA T-O	I. R. C.	07716	0757-1099	1
R58,59	fxd, met. film 100 Ω \pm 1% 1/8w	4	Type CEA T-O	I. R. C.	07716	0757-0401	1
R61	fxd, met. film 68.1K Ω \pm 1% 1/4w	2	Type CEA T-O	I. R. C.	07716	0757-0772	1
R63	var. ww 10K Ω	2	Type 110-F4	C. T. S.	11236	2100-0396	1
R66,67	fxd, met. film 3.40K Ω \pm 1% 1/4w	4	Type CEB T-O	I. R. C.	07716	0698-4642	1
R68,69	fxd, met. film 365 Ω \pm 1% 1/4w	4	Type CEB T-O	I. R. C.	07716	0757-0723	1
R70,71,75	fxd, met. film 3K Ω \pm 1% 1/8w	6	Type CEA T-O	I. R. C.	07716	0757-1093	2
R72	var. ww 250 Ω (Modify)	2	Type 110-F4	C. T. S.	11236	2100-0439	1
R73	fxd, met. film 750 Ω \pm 1% 1/8w	2	Type CEA T-O	I. R. C.	07716	0757-0420	1
R79	fxd, ww 3.3 Ω \pm 5% 1w	2	Type BWH	I. R. C.	07716	0811-1672	1
R81-83	fxd. ww 250 Ω \pm 5% 75w	6	6BR-37	H. H.	73978	0811-1973	2
S1	Switch, PL. LT (RD) ON/OFF SPDT	1	SW616-26	Oak	87034	3101-0100	1
S2	Meter switch, wafer	2		HLAB	09182	3100-1910	1
T1	Power Transformer	2		HLAB	09182	9100-1839	1
VR1,2	Diode, zener 6.2V	4	1N821	N. A. Elect.	06486	1902-0761	4
	Side chassis - right	1		HLAB	09182	5000-6079	
	Side chassis - left	1		HLAB	09182	5000-6080	
	Outrigger chassis	1		HLAB	09182	5000-6090	
	Chassis - heat sink	1		HLAB	09182	5000-6086	
	Bracket transformer	2		HLAB	09182	5000-6087	
	Bracket - P. C. board	1		HLAB	09182	5000-6088	
	Blank panel - front	1		HLAB	09182	5000-6046	
	Panel - front	1		HLAB	09182	5000-6085	
	Cover	2		HLAB	09182	5000-6089	
	Cover - outrigger	1		HLAB	09182	5000-6091	

Reference Designator	Description	Quantity	Mfr. Part # or Type	Mfr. Mfr.	Mfr. Code	Ⓢ Stock No.	RS
	Guard - angle	1		HLAB	09182	5020-5540	
	5 Way binding post (maroon)	2		HLAB	09182	1510-0040	1
	5 Way binding post (black)	4	DF21BC	Superior	58474	1510-0039	1
	Cable clamp 1/4 I. D.	4	T4-4	Whitehead	79307	1400-0330	1
	Line cord plug PH151 7 1/2 ft.	1	KH 4096	Beldon	70903	8120-0050	1
	Strain relief bushing	1	SR-5P-1	Heyco	28520	0400-0013	1
	Knob 17/64 insert pointer	4		HLAB	09182	0370-0101	1
	Knob 3/16 insert	4		HLAB	09182	0370-0179	1
	Knob 1/4 insert pointer	2		HLAB	09182	0370-0084	1
	Barrier strip	2		HLAB	09182	0360-1234	1
	Jumper	16	422-13-11-013	Cinch	71785	0360-1143	4
	Rubber bumper	4	MB 50	Stockwell	87575	0403-0088	1
	Fuseholder	1	342014	Littlefuse	75915	1400-0084	1
	Mica insulator	4	734	Reliance	08530	0340-0174	1
	Meter 2 1/4" size DUAL scale						
	0-70V 0-1.2A	2		HLAB	09182	1120-1144	1
	Bezel 1/6 MOD	2		HLAB	09182	5040-0651	1
	Spring	8		HLAB	09182	1460-0720	2
	Fastener	11	C8091-632-24B	Tinnerman	89032	0510-0275	3
	Insulator, transistor pin	8		HLAB	09182	0340-0166	2
	Insulator	8		HLAB	09182	0340-0168	2
	Rubber bumper	4	4072	Stockwell	87575	0403-0086	1
	Rubber bumper black duro hard 55/60	2	3066	Stockwell	87575	0403-0085	1



NOTES:

1. SCHEMATIC SHOWS (1) OF (2) IDENTICAL SUPPLIES. S1, F1, & LINE CORD ARE SHARED.
2. ALL RESISTORS ARE 1/2 WATT, 5% UNLESS OTHERWISE NOTED.
3. ALL 1/8 W AND 1/4 W RESISTORS ARE 1% IN TOLERANCE.
4. * DENOTES NOMINAL VALUE, COMPONENTS SELECTED FOR OPTIMUM PERFORMANCE.
5. * DENOTES 20 PPM WIDE TEMPERATURE COEFFICIENT.
6. REAR TERMINALS ARE SHOWN IN NORMAL STRAPPING FOR USE OF FRONT PANEL CONTROLS.
7. --- DENOTES VOLTAGE SIGNAL.
8. --- DENOTES CURRENT SIGNAL.
9. R10A & B AND R16A & B ARE DUAL SHUNT FRONT PANEL CONTROLS.
10. TRANSFORMER SHOWN STRAPPED FOR 115 VAC OPERATION. SEE INSTRUCTION MANUAL FOR 220 VAC.

11. DC VOLTAGES WERE MEASURED UNDER THE FOLLOWING CONDITIONS:

- A. SIMPSON MODEL 260 OR EQUIVALENT
- B. 115 VAC INPUT.
- C. VOLTAGES REFERENCED TO +S, UNLESS OTHERWISE INDICATED
- D. VOLTAGES ARE TYPICAL, $\pm 10\%$ UNLESS OTHERWISE INDICATED
- E. ALL READINGS TAKEN WITH SUPPLY IN CONSTANT VOLTAGE OPERATION AT MAXIMUM RATED OUTPUT WITH NO LOAD CONNECTED. CURRENT CONTROLS SHOULD BE TURNED FULLY CLOCKWISE.

CIRCUIT PATENTS APPLIED FOR. LICENSE TO USE MUST BE OBTAINED IN WRITING FROM HARRISON LABORATORIES.

DATE	10-7-65	REV	10-7-65
DESIGNED BY	W. H. HARRISON	CHECKED BY	W. H. HARRISON
APPROVED BY	W. H. HARRISON	DATE	10-7-65
TITLE	6257A SCHEMATIC		
FOR DUAL	0-60V 0-1A	DATE	10-7-65
HARRISON LABORATORIES			
DIV. OF HEWLETT PACKARD			
BERKELEY HEIGHTS, N.J.			

SALES AND SERVICE OFFICES

UNITED STATES and CANADA

ALABAMA

Huntsville, 35802
2003 Byrd Spring Rd. S.W.
(205) 881-4591
TWX: 510-579-2204

ALASKA

Bellevue, Wash. 98004
11656 N.E. 8th Street
(206) 454-3971
TWX: 910-443-2303

ARIZONA

Scottsdale, 85251
3009 No. Scottsdale Rd.
(602) 945-7601
TWX: 602-949-0111

Tucson, 85716
232 So. Tucson Blvd.
(602) 623-2564
TWX: 602-792-2759

CALIFORNIA

North Hollywood, 91604
3939 Lankershim Blvd.
(213) 877-1282 and 766-3811
TWX: 910-499-2170

Sacramento, 95821
2591 Carlsbad Ave.
(916) 482-1463
TWX: 916-444-8683

San Diego, 92106
1055 Shafter Street
(714) 223-8103
TWX: 714-276-4263

Palo Alto, 94303
1101 Embarcadero Rd.
(415) 327-6500
TWX: 910-373-1280

COLORADO

Englewood, 80110
7965 East Prentice
(303) 771-3455
TWX: 910-935-0705

CONNECTICUT

Middletown, 06457
589 Saybrook Rd.
(203) 346-6611
TWX: 710-428-2036

FLORIDA

Miami, 33125
2907 Northwest 7th St.
(305) 635-6461

Orlando, 32803
621 Commonwealth Ave.
(305) 425-5541
TWX: 305-841-2568

St. Petersburg, 33708
410-150th Ave., Madeira Beach
(813) 391-0211 and 391-1829
TWX: 813-391-0666

GEORGIA

Atlanta, 30305
3110 Maple Drive, N.E.
(404) 233-1141
TWX: 810-751-3283

HAWAII

North Hollywood, Calif. 91604
3939 Lankershim Blvd.
(213) 877-1282
TWX: 910-499-2170

ILLINOIS

Skokie, 60076
5500 Howard Street
(312) 677-0400
TWX: 910-223-3613

INDIANA

Indianapolis, 46205
3919 Meadows Dr.
(317) 546-4891
TWX: 317-635-4300

LOUISIANA

New Orleans
(504) 522-4359

MARYLAND

Baltimore, 21207
6660 Security Blvd.
(301) 944-5400
TWX: 710-862-0850

Rockville, 20852
12303 Twinbrook Pkwy.
(301) 427-7560
TWX: 710-828-9684

MASSACHUSETTS

Burlington, 01803
Middlesex Turnpike
(617) 272-9000
TWX: 710-332-0382

MICHIGAN

Southfield, 48076
24315 Northwestern Hwy.
(313) 353-9100
TWX: 313-357-4425

MINNESOTA

St. Paul, 55114
2459 University Ave.
(612) 646-7881
TWX: 910-563-3734

MISSOURI

Kansas City, 64114
9208 Wyoming Place
(816) 333-2445
TWX: 910-771-2087

St. Louis, 63144
2812 South Brentwood Blvd.
(314) 644-0220
TWX: 910-760-1670

NEW JERSEY

Eatontown, 07724
(201) 747-1060

Englewood, 07631
391 Grand Avenue
(201) 567-3933
TWX: 510-230-9709

NEW MEXICO

Albuquerque, 87108
6501 Lomas Blvd., N.E.
(505) 255-5586
TWX: 910-989-1655

Las Cruces, 88001
114 S. Water Street
(505) 526-2486
TWX: 910-983-0550

NEW YORK

New York, 10021
236 East 75th Street
(212) 879-2023
TWX: 710-581-4376

Rochester, 14623
39 Saginaw Drive
(716) 473-9500
TWX: 510-253-5981

Poughkeepsie, 12601
82 Washington Street
(914) 454-7330
TWX: 914-452-7425

Syracuse, 13211
5858 East Molloy Rd.
(315) 454-2486
TWX: 710-541-0482

Endicott, 13764
1219 Campville Rd.
(607) 754-0050
TWX: 510-252-0890

NORTH CAROLINA

High Point, 27262
1923 N. Main Street
(919) 882-6873
TWX: 510-926-1516

OHIO

Cleveland, 44129
5579 Pearl Road
(216) 884-9209
TWX: 216-888-0715

Dayton, 45409
1250 W. Dorothy Lane
(513) 298-0351
TWX: 513-944-0090

OKLAHOMA

Oklahoma City
(405) 235-7062

PENNSYLVANIA

Camp Hill
(717) 737-6791

West Conshohocken, 19428
144 Elizabeth Street
(215) 248-1600 and 828-6200
TWX: 518-660-8715

Monroeville, 15146
Monroe Complex
Building 2
Suite 2
Moss Side Blvd.
(412) 271-5227
TWX: 710-797-3650

TEXAS

Dallas, 75209
P.O. Box 7166, 3605 Inwood Rd.
(214) 357-1881
TWX: 910-861-4081

Houston, 77027
P.O. Box 22813, 4242 Richmond Ave.
(713) 667-2407
TWX: 713-571-1353

UTAH

Salt Lake City, 84115
1482 Major St.
(801) 486-8166
TWX: 801-521-2604

VIRGINIA

Richmond, 23230
2112 Spencer Road
(703) 282-5451
TWX: 710-956-0157

WASHINGTON

Bellevue, 98004
11656 N.E. 8th St.
(206) 454-3971
TWX: 910-443-2303

GOVERNMENT CONTRACTING OFFICE

San Antonio, Texas 78226
Hewlett-Packard
Contract Marketing Division
225 Billy Mitchell Road
(512) 434-4171
TWX: 512-571-0955

CANADA

Montreal, Quebec
Hewlett-Packard (Canada) Ltd.
8270 Mayrand Street
(514) 735-2273
TWX: 610-421-3484
Telex: 01-2819

Ottawa, Ontario
Hewlett-Packard (Canada) Ltd.
1762 Carling Avenue
(613) 722-4223
TWX: 610-562-1952

Toronto, Ontario
Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue West
(416) 249-9196
TWX: 610-492-2382

Vancouver, B.C.
Hewlett-Packard (Canada) Ltd.
2184 W. Broadway
(604) 738-7520
TWX: 610-922-5059

SALES AND SERVICE OFFICES INTERNATIONAL - Electronic Equipment

ARGENTINA

Mauricio A. Suarez
Telecomunicaciones
Carlos Calvo 224
Buenos Aires
Tel. (30-6312) (34-9087)

AUSTRALIA

Sample Electronics (Vic) Pty., Ltd.
9-11 Cremorne Street
Richmond E.1, Victoria
Tel. 42-4757

Sample Electronics (N.S.W.) Pty, Ltd.
4 Grose Street
Glebe, New South Wales
Tel. 69-6338

AUSTRIA

Unilabor H.m.b.H.
Wissenschaftliche Instrumente
Rummelhardtgasse 6/3
P.O. Box 33, Vienna IX/71
Tel. 426 181

BELGIUM

Hewlett-Packard Benelux S.A.
20-24 rue de l'Hopital
Brussels
Tel. 11 22 20

BRAZIL

Ciental Importacao e Comercio Ltda.
Rua des Eliseu Guilherme, 62
Sao Paulo 8
Tel. 70-2318

CHILE

Hector Calcagni
Casilla 13942
Santiago
Tel. 6.42.26

DENMARK

Tage Olsen A/S
Ronnegade 1
Copenhagen 0
Tel. 29 48 00

FINLAND

INTO O/Y
Meritullinkatu 11
P.O. Box 153
Helsinki
Tel. 6 11 33

FRANCE

Hewlett-Packard France
150 Boulevard Massena
Paris 13
Tel. 707 97 19

Hewlett-Packard France
2 rue Tete d'Or
Lyon, 6 - Rhone
Tel. 52 35 66

GERMANY

Hewlett-Packard Vertriebs-GmbH
Kurfürstendamm 95
Frankfurt a. Main
Tel. 52 00 36

Hewlett-Packard Vertriebs-GmbH
Reginfriedstrasse 13, Munich 9
Tel. 49 51 21

Hewlett-Packard Vertriebs-GmbH
Beim Strohnhaue 26/28
Hamburg 1
Tel. 24 05 51

Hewlett-Packard Vertriebs-GmbH
(Technisches Büro)
Herrenberger Strasse 110
Böblingen, Württemberg
Tel. 6971

Hewlett-Packard Vertriebs-GmbH
Lietzenburger Strasse 30
1 Berlin W 30
Tel. 24 86 36

Hewlett-Packard Vertriebs-GmbH
Achenbachstrasse 15
4 Düsseldorf 1,
Tel. 68 52 58

GREECE

K. Karayannis
Klafi Monos Square
Athens 124
Tel. 230 301

INDIA

The Scientific Instrument Co., Ltd.
6, Tej Bahadur Sapru Road
Allahabad 1
Tel. 2451

The Scientific Instrument Co., Ltd.
240, Dr. Dadabhai Naoroji Road
Bombay 1
Tel. 26-2642

The Scientific Instrument Co., Ltd.
11 Esplanade East, Calcutta 1
Tel. 23-4129

The Scientific Instrument Co., Ltd.
30 Mount Road, Madras 1
Tel. 86339

The Scientific Instrument Co., Ltd.
B-7, Ajmeri Gate Extn.
New Delhi 1
Tel. 271053

IRAN

Telecom, Ltd.
P.O. Box 1812
Teheran
Tel. 43850, 48111

ISRAEL

Electronics & Engineering Ltd.
Division of Motorola Israel Ltd.
16, Kremenetski Street, Tel-Aviv
Tel. 35021

ITALY

Hewlett-Packard Italiana S.p.A.
Viale Lunigiana 46, Milan
Tel. 69 15 84

Hewlett-Packard Italiana S.p.A.
Palazzo Italia
Piazza Marconi 25, Rome-Eur
Tel. 591 2544

JAPAN

Yokogawa-Hewlett-Packard Ltd.
59, 1-chome
Yoyogi
Shibuya-ku
Tokyo,
Tel. 370-2281

Yokogawa-Hewlett-Packard Ltd.
8, Umeda
Kita-ku, Osaka City
Tel. 313-0091

Yokogawa-Hewlett-Packard Ltd.
4, 3-chome
Himeikedori
Chigusa-ku, Nagoya City
Tel. 751-8545

KOREA

American Trading Co., Korea, Ltd.
Seoul P.O. Box 1103
112-35 Sokong-Dong
Jung-ku, Seoul
Tel. 3.7049, 3.7613

LEBANON

Constantin E. Macridis
Clemenceau Street
Clemenceau Center
Beirut
Tel. 220846

NETHERLANDS

Hewlett-Packard Benelux, N.V.
23 Burg, Roellstraat
Amsterdam, W.
Tel. (020) 13 28 98

NEW ZEALAND

Sample Electronics (N.Z.) Ltd.
8 Matipo Street
Onehunga S.E. 5, Auckland
Tel. 565-361

NORWAY

Morgenstjerne & Co. A/S
Ingeniofirma
6 Wessels Gate, Oslo
Tel. 20 16 35

PAKISTAN

Mushko & Company, Ltd.
Oosman Chambers
Victoria Road
Karachi 3, West Pakistan
Tel. 54601

Mushko & Company, Ltd.
Zirat Chambers
31, Jinnah Avenue
Dacca, East Pakistan
Tel. 80058

PANAMA

Electronico Balboa, S.A.
P.O. Box 4929
Panama City
Tel. 3-0833

PERU

Fernando Ezeta B
Av. Petit Thouars 4719
Mira Flores, Lima
Tel. 5-0346

PORTUGAL

Telectra
Rua Rodrigo da Fonseca 103
P.O. Box 2531, Lisbon 1
Tel. 68 60 72

PUERTO RICO

San Juan Electronics, Inc.
Ponce de Leon No. 150, Stop 3
Pta. de Tierra Sta., San Juan
Tel. 725-3342

SPAIN

Ataio Ingenieros
Enrique Lareta 12
Madrid, 16
Tel. 235 43 44-5

SOUTH AFRICA

F.H. Flanter & Co. (Pty.), Ltd.
Rosella House
Buitencingle Street
Cape Town
Tel. 3-3817

F.H. Flanter & Co. (Pty.), Ltd.
P.O. Box 200, Bramley
775 Pretoria Main Road
Wynberg, Transvaal
Tel. 40-6871

SWEDEN

HP Instrument AB
Centralvagen 28
Solna Centrum
Tel. 08-83 08 30

HP Instrument AB
Box 4028
Indunagatan 28A
Molndal 4
Tel. 27 68 00

SWITZERLAND

Max Paul Frey
Wankdorffeldstrasse 66
Berne
Tel. (031) 42 00 78

TAIWAN

Hwa Sheng Electronic Co., Ltd.
P.O. Box 1558
21 Nanking West Road
Taipei
Tel. 46076, 45936

TURKEY

Telekom Engineering Bureau
P.O. Box 376 - Galata
Istanbul
Tel. 49 40 40

UNITED KINGDOM

Hewlett-Packard Ltd.
Dallas Road
Bedford, England
Tel. 68052

VENEZUELA

Citec, C.A.
Edif. Arisan-Of. No. 4
Avda. Francisco de Miranda
Chacaito
Caracas
Tel. 71.88.05

YUGOSLAVIA

Belram S.A.
83 Avenue des Mimosas
Brussels 15, Belgium
Tel. 35 29 58

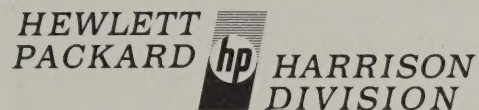
**For Sales and Service
Assistance in Areas Not
Listed Contact:**

EUROPE

Hewlett-Packard, S.A.
54 Route des Acacias
Geneva, Switzerland
Tel. (022) 42.81.50

ELSEWHERE

Hewlett-Packard
1501 Page Mill Road
Palo Alto, California 94304, U.S.A.
Tel. (415) 326-7000



The information contained in this booklet is intended for the operation and maintenance of Harrison equipment and is not to be reproduced without written consent of:

Harrison Division of Hewlett-Packard Company

PATENT NOTICE

Patents have been applied for on circuits used in this power supply. Buyer is not licensed to reproduce drawings or to utilize the circuit without written permission from Harrison Division of Hewlett-Packard Company.

CLAIM FOR DAMAGE IN SHIPMENT

This equipment should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition which is to be made of the equipment and arrange for repair or replacement.

HARRISON DIVISION OF HEWLETT-PACKARD COMPANY

100 LOCUST AVENUE • BERKELEY HEIGHTS, NEW JERSEY 07922 • 464-1234 • AREA CODE 201 • TWX 201-464-2117

HEWLETT
PACKARD  HARRISON
DIVISION